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VANADIUM STEEL.*

THE CHARACTERISTICS OF A NEW STEEL FOR MACHINE CONSTRUCTION.

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AMONG the many new alloy steels which have been brought out in the last few years, the vanadium steels are probably the latest addition which steel makers have adopted, and this has been done after many experiments had been made. This steel, in many different percentages of alloy, has been given numerous tests of many different characters in order to determine the qualities of the steel and its action when submitted to the various strains and stresses it is liable to meet when put into actual use. These tests would seem to place it in the front rank of high-grade alloy steels, although it will be, after all, the actual use of it for the moving parts of machinery and other purposes that will demonstrate to a certainty its wearing qualities, as well as its ability to withstand strains and stresses.

strains applied in a totally different manner to that under which it was tested by simply pulling a bar until it broke.

In machine construction, those parts which are liable to failure while in use require high dynamic qualities, that is, resistance to repeated stresses, alternating stresses, simple repeated, or alternating impacts, and fatigue, the latter being the outward and visible sign of the inter-molecular vibratory deterioration.

Thus a new field is being opened out, and while vanadium affects steel in a manner that tends to increase the static strengths of other alloys, it also raises the dynamic properties to an extent that is not thought of in other alloys. It is here that vanadium gives an added value to the high grade alloy steels.

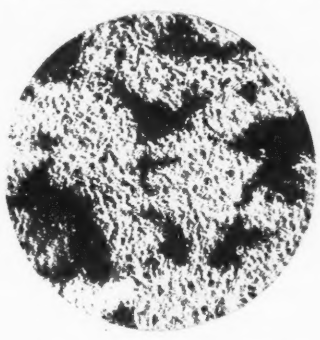

Fig. 1. Carbon Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

Fig. 2. Nickel Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

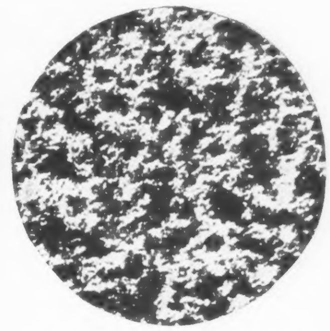

Fig. 3. Vanadium Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

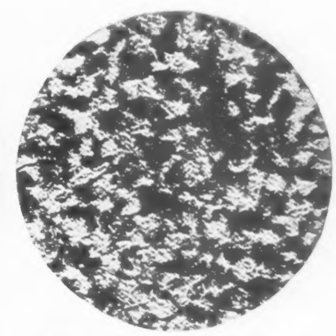

Fig. 4. Vanadium Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

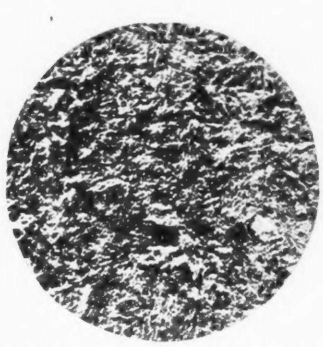

Fig. 5. Vanadium Crank-shaft Steel, magnified 350 Diameters. Heat Treatment: Quenched from 1650 deg. F. and Annealed at 1000 deg. F. for one hour.

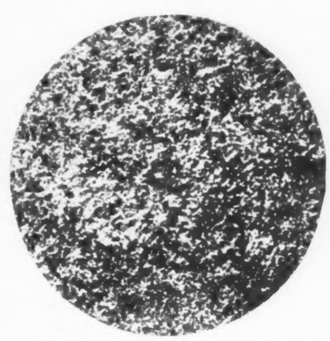

Fig. 6. Vanadium Crank-shaft Steel, magnified and Treated same as Sample in Fig. 5.

Fig. 7. Vanadium Mesh-gear Steel, magnified 350 Diameters. Heat Treatment: Quenched from 1750 deg. F. in Lard Oil; Annealed at 675 deg. F. for one-half hour in Lead Bath; Cooled in Air.

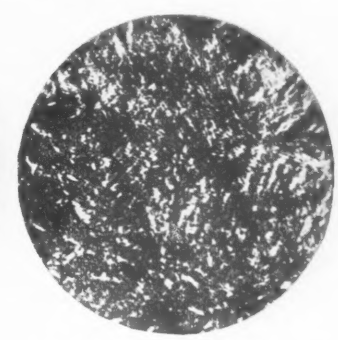

Fig. 8. Vanadium Mesh-gear Steel, magnified and Treated the same as Sample in Fig. 7. In both samples Undecomposed Martensite is noticeable.

As manufacturers are beginning to use this steel for different purposes, the positive proof will be forthcoming in the very near future, if it has not already been obtained by those who are using it.

The mechanical engineers of the present day have been forced to become better metallurgists than they ever were in the past, in order to intelligently design high-grade machinery, as the, so-called, mysterious failures of steels are becoming more numerous and more pronounced every day.

These, so-called, mysterious failures of steel, which occur in high-grade alloys the same as in the Bessemer steel rails, although not as frequently, have proven to the engineers of to-day that the old custom of judging a steel by its resistance to static load, and the amount it would stretch under that load, is not always to be depended on.

The uses to which steel is put call upon it to resist

Some recent tests of armor plate, made by the United States Government, give an illustration of this. In the past it has been the custom to make armor plate as hard as possible, and at the same time retain a high degree of strength. For this reason chromium was used as the principal alloy, and in many cases the only alloy, as it gave steel a hardness that is not obtainable with any other. In the recent test spoken of, a vanadium-chrome steel was used with a hard outer shell and a very soft core, similar to the condition obtained by carbonizing. The result was that it withstood a much higher test of the impact blows delivered by the shots from a gun than the formerly used hard steels.

Vanadium acts as a physic on the other elements and is a very powerful medicine, as very small percentages give the desired results; but if used in too large a percentage it will dynamically poison the metal. Sometimes the vanadium will perform its mission properly and physic through the metal, leaving but a trace to show on analyzing the steel, but in the majority of instances it stays in the metal. Vanadium

* For additional information regarding the manufacture and characteristics of this and kindred steels, see the article in the September, 1907, issue of MACHINERY: Nickel Steel, and previous articles referred to in the same issue.

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steel is the most difficult of all the alloy steels for the chemist to get a correct analysis of.

Vanadium has the property of elusiveness to a very marked degree, and must be handled by the steel maker very carefully in order to get the necessary results. It is, therefore, marketed in the form of ferro-vanadium in the proportions of about two parts of iron to one part vanadium. For machinery purposes it is generally alloyed with steel in percentages of from 0.10 to 0.30 per cent, but it has been tried as a tool steel with as high as 3 per cent, and when this was compared with a 3 per cent tungsten tool steel by cutting

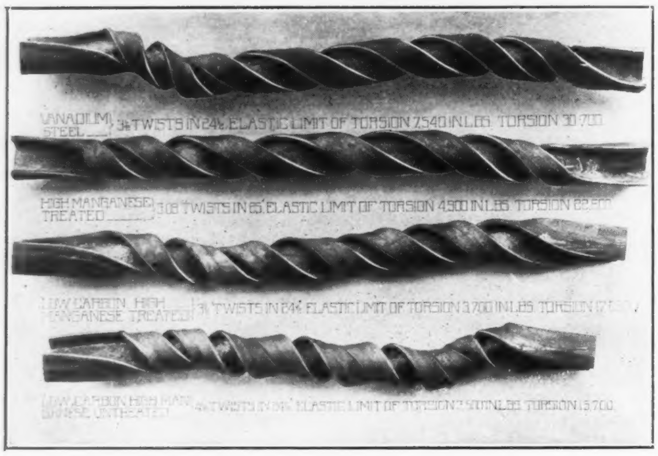


Fig. 9. Axle Steel Samples showing Difference in Physical Qualities Length, 52 inches; Depth, 2 inches; Width, 1 1-2 inch; Thickness of Flanges, 3-16 inch at Edge, 3-8 inch at Web; Thickness of Web, 3-16 inch.

a chilled white iron plate, and then collecting and weighing the cuttings, the vanadium tool steel was found to excel the tungsten tool steel by 25 per cent. It is used in manufacturing a tool steel by one steel maker, in this country, who uses vanadium in a small percentage, tungsten in a large percentage, chromium in a small percentage, and a few other ingredients in small percentages, and the tests given this steel show that it excels other tool steels by from 10 to 20 per cent in their cutting qualities.

Vanadium is not like nickel, chromium, manganese and other mineral elements used in high-grade steel making, as it contains within itself no virtues but in its action as a physic

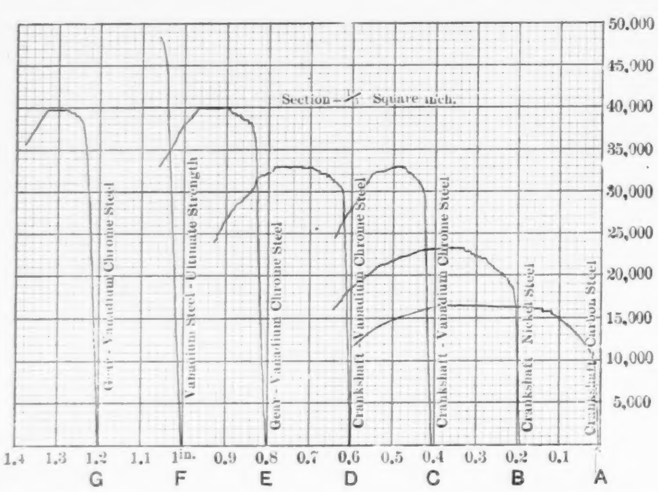


Fig. 10. Chart taken on Olsen Testing Machine. Test Bar, 1-5 square inch Section. Figures should be multiplied by 5.

on the other elements. It imparts some very desirable properties, hence its most successful application lies in the direction of the quaternary steels such as chrome-vanadium or nickel-vanadium. In a technical sense it retards the segregation of the carbides, thereby producing in steel a high degree of homogeneity and a grain of great uniformity and fine texture. This is best shown by the series of microphotographs Figs. 1 to 8, which are magnified 350 diameters. One of these shows the ordinary carbon steel, another nickel steel axle stock, and the others vanadium-chrome steel under different degrees of heat treatment.

These photographs were furnished the writer by the Ford Motor Co., Detroit, Mich., from a special heat of 50 tons which it had rolled for its own use. This steel is being used on all the automobiles built by the company.

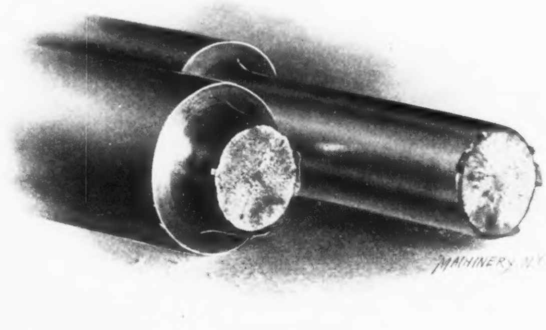


Fig. 11. Test Bar, 1-2 inch Diameter. Heat Treated for Mesh-gears. Star Fracture.

In retarding the segregation of the carbides, vanadium renders steel susceptible to great improvements by heat treatment or tempering, and in this manner the steel can be prepared to resist wear and erosion. It also renders possible the natural formation of the "sorbitic" structure which is necessary in metals which have to withstand wear and erosion.

Vanadium steel also has self-lubricating properties to a greater extent than other high-grade steels, hence it is more

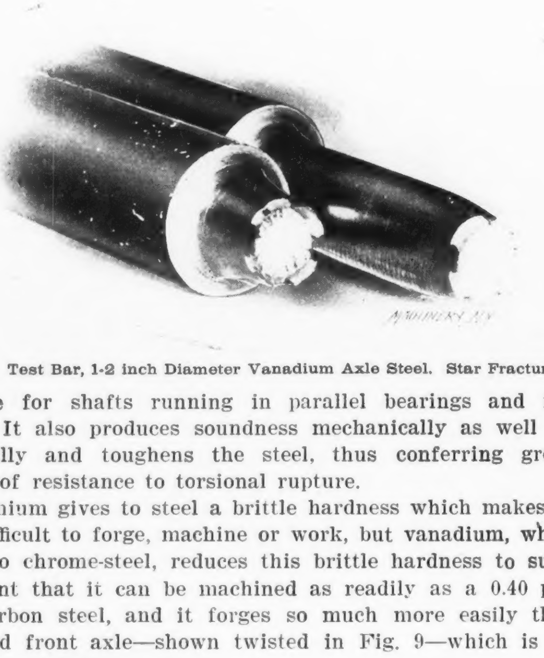


Fig. 12. Test Bar, 1-2 inch Diameter Vanadium Axle Steel. Star Fracture.

valuable for shafts running in parallel bearings and for gears. It also produces soundness mechanically as well as chemically and toughens the steel, thus conferring great powers of resistance to torsional rupture.

Chromium gives to steel a brittle hardness which makes it very difficult to forge, machine or work, but vanadium, when added to chrome-steel, reduces this brittle hardness to such an extent that it can be machined as readily as a 0.40 per cent carbon steel, and it forges so much more easily that the Ford front axle—shown twisted in Fig. 9—which is 52

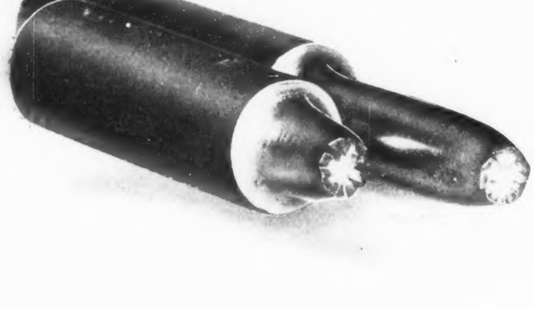


Fig. 13. Test Bar, 1-2 inch Diameter, Vanadium Crank-shaft Steel. Star Fracture.

inches long, 2 inches deep, of I-beam section, with the web only 3/16 inch thick, is being forged in three heats. The first heat is used to forge the straight I-beam part; the second heat is used to forge the arm for the steering-rod connection and the projections for the steering pivot, on one

end, while the third heat is required to forge the same on the other end of the axle. Automobile axles of similar design, when forged out of chrome-nickel steel, require from 15 to 20 heats to give them the proper shape, and even then the dies give a great deal of trouble.

For these reasons the nickel or chrome-nickel axles are

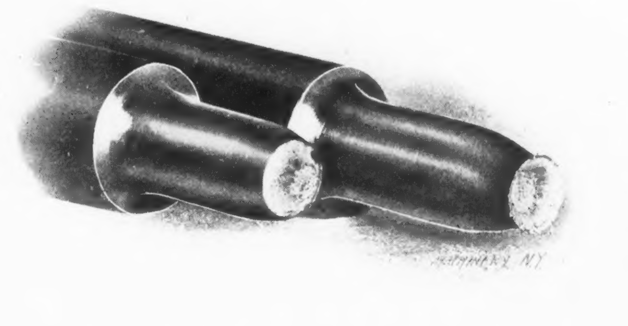


Fig. 14. Test Bar, 1-2 inch Diameter, Vanadium Crank-shaft Steel. Cup Fracture.

usually forged in two halves, and welded together in the center by the electric welding process.

Vanadium, by reducing the brittle hardness of chromium and rendering steel very homogeneous, makes it capable of

TABLE I.

Specimen.	Tensile Strength in pounds per square inch.	Elastic Limit in pounds per square inch.	Elongation in 2 inches, per cent.	Reduction of Area, per cent.
A	82,500	50,000	30	66
B	116,000	90,000	21	71
C	165,000	147,000	11	61
D	165,000	147,000	16	59
E	200,000	185,000	11	56
F	228,375	228,375	..	..
G	198,750	190,000	9	34

being machined as easily as ordinary carbon steel, that is, running at the same speed and using high-speed tools. The Ford Motor Co. says: "Thus we find in actual practice that vanadium steel costs no more than ordinary carbon steel and vastly less than nickel, because of the saving in machining, forging and tempering, and the greater accuracy we are able to obtain, owing to uniformity of metal and the lighter weight of metal we are capable of using, owing to its great strength."

TABLE II.

Specimen.	Tensile Strength in pounds per square inch.	Elastic Limit in pounds per square inch.	Elongation in 2 inches, per cent.	Reduction of Area, per cent.
1	88,000	64,500	29	59
2	98,750	67,500	25	77
3	127,500	110,000	14	59
4	147,000	140,750	17	57
5	165,000	155,000	16	55
6	176,500	175,000	7	27

Fig. 9 shows the comparative amounts of torsion which vanadium and some other steels will stand by twisting. Fig. 10 shows the comparative strengths of carbon, nickel and vanadium-chrome steels. The figures for this chart read as in Table I.

A is a 0.06 per cent carbon steel, heat treated. *B* is a 0.07 per cent nickel steel, heat treated. The others are all taken from the same bar of vanadium steel and subjected to different degrees of heat treatment. *F* merely shows the ultimate strength.

Vanadium steel can also be given a wide range of strengths together with hardness or softness by properly heat treating. This is best shown by the accompanying Table II. of test bars which were pulled on an Olsen testing machine by the Ford Motor Co. especially for the writer. The test bars were all made out of one bar of steel.

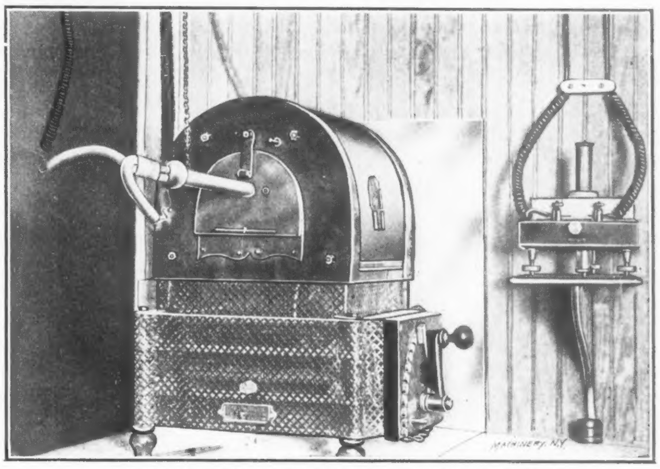
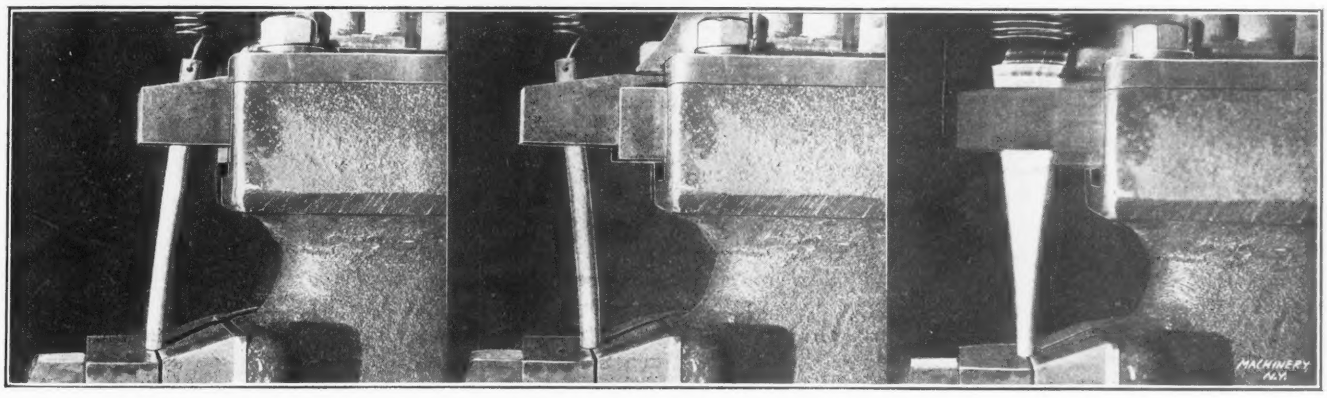


Fig. 15. Heat Treatment Furnace, electrically heated.

Specimens 1 and 2 are in their softest condition; specimen 3 is in the condition of an axle; specimens 4 and 5 are in the crank-shaft condition; and specimen 6 is in a mesh gear condition.

Other tests have shown much higher strengths, but the remarkable features of these tests are the way the elastic limit has been brought up nearly to the tensile strength, and the high reduction of area.



Figs. 16, 17 and 18. Alternating Impact Machine.

Figs. 11, 12, 13, and 14, which are photographs of four of these bars, will more clearly show the reduction as well as the almost perfect breaks.

TABLE III.

Kind of Steel.	Pendulum Impact, Foot-pounds.	Alternating Impact, Number of Stresses.	Falling Weight on Notched Bar, Number of Blows.	Rotary Vibrations, Number of Revolutions.
Carbon axle stock..	12.3	960	25	6,200
Nickel axle stock...	14.0	800	35	10,000
Vanadium axle stock......	16.5	2700	69	67,500
Vanadium crank-shaft stock.......	12.0	1850	76	......
Vanadium mesh gear stock........	6.0	800	..	......

Fig. 15 shows the furnace which was used in treating the steels in Table II. To it was attached a pyrometer, which was

fastened to the wall above, and therefore does not show in the cut, but the wire at the back leads to it. With this it was possible to regulate the heat to the exact degree required for obtaining the heat treatment wanted for each specimen.

While the static strengths before stated are and can be made the equal of almost any alloy steel, it is in the dynamics that vanadium steel excels all others, and these are becoming more and more the real tests of steel for use in moving machinery or where strains other than a direct pull are put upon it.

The dynamics of vanadium steel as compared with carbon and nickel steel are shown by the tests given in the accompanying Table III. These tests were made with a bar ½ inch in diameter.

These tests have given the present day engineer something tangible on which to base the size, shape and strength in designing parts for machinery which has to withstand great strains. In the past the engineer was contented if he knew the static strengths were high, but these, in reality, were but about 15 per cent of his requirements, and having made sure of these, he hoped that in some way he had acquired the other 85 per cent.

At the present time, however, by submitting his steels to the dynamic tests, he no longer hopes, but knows, what his steel will stand under all kinds of conditions and strains, and is therefore enabled to do his designing with much more assurance and knowledge of what the different parts will require.

Figs. 16, 17 and 18 show the machine on which the alternating impact tests were made, the first two showing it in its extreme position at each end, and the third showing it while in motion.

* * *

EFFECT OF MOISTURE ON WOOD.

The Forest Service of the U. S. Department of Agriculture has just issued a publication entitled "The Strength of Wood as Influenced by Moisture," in which is shown the strength of representative woods in all the degrees of moisture, from the green state to absolute dryness, and the effects of resoaking. By different methods of seasoning, two pieces of the same stick may be given very different degrees of strength.

Wood, in its green state, contains moisture in the pores of the cells, like honey in a comb, and also in the substance of the cell walls. As seasoning begins, the moisture in the pores is first evaporated. This lessens the weight of the wood, but does not affect its strength. It is not until the moisture in the substance of the cell walls is drawn upon, that the strength of the wood begins to increase. Scientifically, this point is known as the "fiber-saturation point." From this condition to that of absolute dryness the gain in the strength of wood is somewhat remarkable. In the case of spruce, the strength is multiplied four times; indeed, spruce, in small sizes, thoroughly dried in an oven, is as strong, weight for weight, as steel. Even after the reabsorption of moisture, when the wood is again exposed to the air, the strength of the sticks is still from 50 to 150 per cent greater than when it was green. When, in drying, the fiber-saturation point is passed, the strength of wood increases as drying progresses, in accordance with a definite law, and this law can be used to calculate, from the strength of a stick at one degree of moisture, what its strength will be at any other degree.

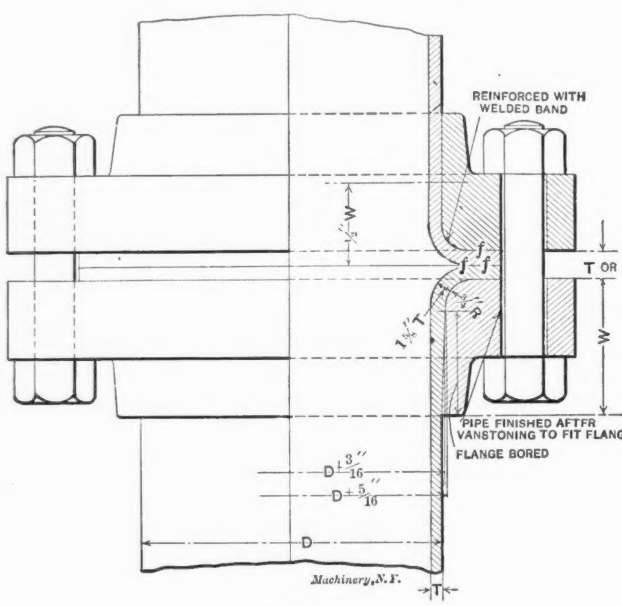
Manufacturers, engineers, and builders need to know not only the strength, but the weakness, of the materials they use, and for this reason they are quite as much interested in knowing how timbers are weakened by knots, checks, cross-grain, and other defects, as they are in knowing how they are affected by moisture. It is obvious that where timbers are certain to be weakened by excessive moisture they will have to be used in larger sizes, for safety. So far, engineers of timber tests, while showing that small pieces gain greatly in strength, do not advise counting on the same results in the seasoning of large timbers, owing to the fact that the large timbers usually found in the market have defects which are sure to counterbalance the gain from seasoning.

MATERIALS FOR CONTROL OF SUPERHEATED STEAM.*

Since the introduction of superheated steam as a large factor in economy in stationary power plant use, the question of what type of material is best for the proper controlling of the resulting high temperatures has caused a great deal of investigation and interest. This article treats particularly of what might be called in a general way piping systems, which systems are made up of pipe, fittings, valves, and the necessary details connected therewith, such as joints, gaskets, etc., and are taken up separately.

Pipe.

There can be little question as to the matter of pipe except quality. Of course, welded wrought iron or steel pipe is successful, but the difference in the quality of pipe is very material. As in nearly all instances in a superheated steam station the old fashioned screwed joint is not satisfactory, it is necessary to do what is termed "work" the pipe—that is, weld, van Stone, etc.—to make either a welded, van Stone, or other joint of the same general description. In the cut is shown what is known as a van Stone joint. For this work the pipe made from open hearth steel is by far the best for manufacturing reasons, because it can be properly "worked," there being less carbon, and the quality is much more uniform. Bessemer steel pipe will very often act in a satisfactory manner, but one is never sure that Bessemer will run even, and, therefore, troubles may result. It is practically impossible to "work" wrought iron pipe. In making what is known as a van Stone joint, the pipe is nearly sure to split very badly, not only at the weld, but all around its outer circumference.



Van Stone Joint.

Nearly opposite qualities from those used for getting good results from "working" pipe are required for threading. A good quality of wrought iron will cut and thread more easily with standard pipe machines and standard dies than a steel pipe, and a Bessemer steel pipe will thread much more easily with standard dies than open hearth. A great many manufacturers have difficulties in threading open hearth steel pipe, for the reason that they set the dies exactly the same as if they were cutting other qualities. This causes ripping of threads, etc. The die in a pipe machine should be set at a greater angle with the radius of the pipe, passing through the point of contact of the die, for soft steel than it would be for other kinds, and this in itself will very often eliminate great troubles in this line.

The ordinary commercial pipe will stand more pressure than the average person believes. A standard 1-inch piece of welded pipe will usually not break under 1,600 pounds per square inch hydraulic pressure. Full weight pipe is suitable for any temperature and any working pressure up to 225 or 250

* Paper by M. W. Kellogg, read before the American Society of Mechanical Engineers, May Meeting, 1907.

pounds, as long as it is not thinned at any point by cutting and threading.

Fittings.

The designs of fittings as generally manufactured for different purposes are, in a general way, satisfactory, with the one exception that very few manufacturers on their standard articles include what is known as the "long fillet" between the body of the fitting and the flange. This is a very desirable point, due to the fact that at this place there is the greatest strain from shrinkage in the molds, which also tends to develop porous spots. Most large users of this type of material have learned this thoroughly, and design their fittings accordingly. The quality of the material in fittings, however, is a very important thing in connection with superheated steam.

The latest practice is to do away with fittings entirely on high pressure steam lines, and put what are known as "nozzles" on the piping itself. This is accomplished by welding wrought steel pipe on the side of another section, so as to accomplish the same result as a fitting. In this way rolled or cast steel flanges and a van Stone or welded joint can be used. This method has three distinct advantages, to wit:

a. The quality of the metal used, for reasons explained hereafter, when the subject of the effect of heat on metals is taken up.
b. The lightening of the entire work.
c. The doing away with a great many joints.

As a general average, at least 50 per cent of the joints can be left out, and sometimes this proportion runs up as high as 60 or 70 per cent, according to the layout of the system. If this method is employed, substantial welds must be made, not only to stand the pressure required, but also the strain.

Valves.

It is important to have a good design of valve. In general, nearly any of the designs made by the best manufacturers are entirely suitable; such as a broken or solid wedge valve of the ordinary type, under the condition that all machine work is done thoroughly and the quality of metal used is of high grade, is satisfactory for the purpose intended.

Metals.

As a rule, different authorities vary slightly in their statements as to what temperatures different metals will stand with good results. German authorities state that cast iron should not be used above 480 degrees F. Other authorities allow us to go as high as 575 degrees F. Above these temperatures, in cast iron, the limit of elasticity is reached with a pressure varying from 140 to 175 pounds. Under such conditions the material is strained and does not resume its former shape, and eventually shows surface cracks, which continue to grow. These temperatures and pressures also lead in time to a shrinkage of all parts, and to a structural alteration of the metal, which results in leakages in valves at the seatings. Therefore, it would seem that iron castings are not suitable for either fittings or valves to be used in any superheated steam work.

The only adaptable metal is cast steel. Results of tests on this metal for the effect of temperature are such that at 572 degrees F., the reduction in breaking strength only amounts to about 1.1 per cent, and at 752 degrees F. to about 7.8 per cent. Therefore, it seems that this metal is practically capable of withstanding all pressures and temperatures up to at least 800 degrees F., without showing any appreciable weakness.

The influence of high temperatures on bronze, etc., is very material. At ordinary temperatures this metal has a breaking strength of about 34,100 pounds per square inch and an elongation of 36 per cent. At 572 degrees F. the breaking strength falls to about 19,500 pounds per square inch and the elongation to 11.5 per cent. At 662 degrees F., which is quite a common temperature, as the steam leaves the superheaters, the breaking strength of bronze only amounts to 12,200 pounds per square inch and the elongation at the breaking point is only approximately 1¾ per cent. This seems to eliminate entirely brass or bronze of ordinary composition for use with highly superheated steam.

The effect of temperature on nickel is very similar to that on cast steel, and in consequence this material is very suitable for use in connection with highly superheated steam. Even neglecting the special quality of nickel seatings, on account of the great toughness of this metal and the methods which can be used for securing rings of this substance to the valves and conical surfaces, it has the special advantage of having the coefficient of contraction and expansion with temperature almost exactly the same as that of cast steel, so that no slackness of the rings occurs and the valves remain absolutely steam tight. There are instances in which valves constructed with nickel seating have been satisfactorily used with steam temperatures up as high as 932 degrees F. Seats, disks, and bushings made of brass or plain bronze do not retain their shape.

For spindles on superheated steam works nickel steel is recommended. Seatings in valves should not only be screwed in, but also pinned in addition, using a fine thread which is very long, to give a tight joint. Seats should also have a flange on the top that makes a joint with the body when screwed down, which prevents the tendency to leak through.

Joints.

It is generally acknowledged that the old-fashioned screwed joint, no matter how well made, would not be suitable for superheated steam work. This leaves for discussion two general types, *viz.*, welded joints and what are generally known as van Stone or climax joints, that is, any joint where the pipe is turned over the face of the flanges. In welding a flange on a piece of pipe, great care must be taken to see that the weld is perfect, because of the unequal thicknesses of the metals to be so welded. If the weld is thoroughly made, this type of joint is very good, although for erection purposes, due to the fact that the flanges cannot swivel, it does not equal the turned-over joint as mentioned above. The manufacturing expenses in making a welded joint are also much more for the same type of work accomplished, on account of the necessity of doing all finishing work after all rough work, such as welding and bending, has been completed.

In regard to the turned over or van Stone joint, the quality of its manufacture seems to be the most important feature. This joint can be made in a careless way where the pipe is in no way thickened up and only faced on the front. A joint of this latter kind does not give good results, principally for two reasons:

a. The thinness of the metal on the turned-over portion; and
b. On account of the recesses left between the back of the pipe on the turned over portion and the flange, due to the pipe not being finished at this point.

The writer believes, however, if this joint is properly made, it is equal to the welded joint as a manufactured article, and superior to the welded joint as an article for erection.

To have this type well made, the pipe on the end should be thickened up an amount sufficient so that after the joint is turned over there will be enough metal left to face the turned over portion on the front, on the outer edge, and on the back. We, of course, take for granted that the flanges are finished on the front. After the work above mentioned is done, the pipe should be as thick on the turned over portion as the original thickness, or very close to it. The point made of facing the turned over portion of the pipe on the back is an exceedingly important one, much more so than most people seem to realize. In reference to making up a joint, it is certain that the face of all flanges or pipe where a joint should be made ought to be given a fine tool finish and have the face level, and then a gasket of some description used.

Gaskets.

There are large numbers of gaskets manufactured of all types and descriptions. It is very hard to take up this subject and be fair to each of the manufacturers, for the reason that practically no one has ever had experience with every type made, to judge for himself, and hearsay would lead us to suppose that all of them are at one time perfect and at other times useless. The writer has used many different types of gaskets, however, and has obtained the best results with a corrugated soft Swedish steel gasket with "Smooth-on" applied, and with the McKim gasket, which is of copper or bronze surrounding asbestos. The ordinary corrugated copper gasket is a very popular make and has been used a great deal. On superheated steam, usually sad results follow. There seems to be some peculiar action that causes this, as on super-

heated steam lines a corrugated copper gasket will in time pit out in some part oi the flange nearly through the entire gasket.

The wear of a gasket depends largely on the method of pulling up bolts on flanges. If joints are pulleo up entirely on one side and left loose on the other, and then taken up on that side, trouble with the gasket is almost certain. The bolts should be taken up gradually all around the flange. The experience of the erecting crews on high class superheated steam lines is an exceedingly important thing. The average steam fitter is not suited to this type of work. Most troubles can be eliminated by using only steam fitters experienced in the type of work under consideration.

* * *

PHOTOGRAPHING DRAWINGS.

Photographing drawings to a greatly reduced scale, for the purpose of record, or even for use in the shop, is coming to be quite common practice in the larger manufacturing plants. The Schenectady works of the American Locomotive Company follows this practice extensively for card records, and has a room in the engineering building specially fitted for the purpose. The standard size tracings of locomotive erecting "cards" are about 25 x 66 inches, and these are reduced to 8¼ inches length, a 6½ x 8½-inch plate camera being used. One plate is large enough for the reductions of two tracings, so, for example, the side elevation and cross-sections, or any other combination of two tracings desired, may be photographed on the same plate.

The tracings are photographed by transmitted light, as experience has demonstrated that the results are more uniform and generally satisfactory than when photographed by reflected light. North light is used, a large "window" facing the north having been provided. The window is double, there being two frames, each carrying a pane about 4 x 11 feet. The frame carrying the inner pane is swung on hinges at one end, and a circular track and trolley supports the opposite end, this being necessary because of the great weight and length of the frame and pane. Both panes are mounted flush in their frames, facing each other, so that when the swinging frame is closed upon the stationary frame, the panes are closely pressed together.

The tracings are mounted on the outer pane by stickers at the corners, and then the inner frame is closed upon it, thereby pressing the tracing down flat, holding it firmly and without wrinkles. The large size of the "window" permits four standard tracings to be mounted at once. These may be the locomotive side elevation, and cross-sections, and the boiler side elevation, and cross-sections, thus compressing on two comparatively small plates all the general data of a locomotive not carried on the specification card.

* * *

A good illustration of the cost of selling goods and the apparently extravagant prices that must be charged for small articles that can be cheaply made, is the safety razor. One of these useful tools of a certain make is sold for, say $5, including one dozen blades. Extra blades are sold for 50 cents a dozen. Now, of course, the principal part of any razor is the blade, but here we have a dozen blades sold for one-ninth the price charged for the handle and its case. Now, while the handle is nicely made, no doubt it and its case could be produced with some profit for 50 cents. This leaves $4 for profit and selling costs, which seems like a most exorbitant figure. No doubt it does represent a handsome profit, but not as much as is derived from the sale of the blades, notwithstanding their low price. The reason is simply that when a razor has been sold, there is no further selling cost of consequence. Every user is a customer for blades without solicitation.

GENERATING A LARGE WORM-WHEEL.

In the December, 1904, issue of MACHINERY was described a machine built by the Eberhardt Bros. Machine Co. of Newark, N. J., for cutting the teeth of worm-wheels to the proper form without the use of a hob. This machine is in daily use in this plant, having been built for custom work. While the principle on which it works was described in the article referred to, it may be worth while to explain it again in a few words.

Fig. 1 is a partial view showing a worm, A, meshing with a worm-wheel, B. The shape of the tooth of the worm-wheel should be the same as would be given to it by the worm if the wheel were made of some plastic material, like clay or wax,

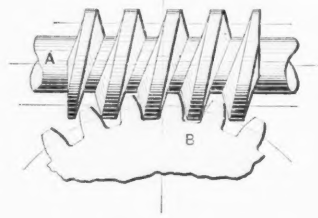


Fig. 1. Section of Worm-wheel Meshing with Worm.

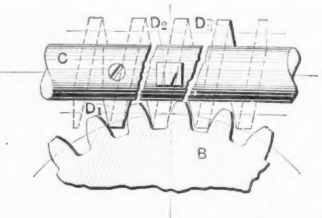


Fig. 2. Helical Path of Fly-tool for Cutting Worm-wheel shown in Fig 1.

and it were revolved with the worm at the proper rate. In usual practice this form is obtained by replacing the worm with a hob, having cutting teeth of the same shape as the worm threads, the hob being fed into the work with work and hob revolving at the proper speed. This hob has to have a multiplicity of teeth to give the same effect as that produced by the theoretical solid worm on the clay or wax wheel. The way in which this same correct shape can be formed with a single tool will be evident from Fig. 2. Here the worm of Fig. 1 shows in the dotted lines. D_1 is a tool held in boring bar C, with an outline exactly coinciding with the thread of the imaginary worm at the point where it is located. If the wheel B and boring bar C are revolved together continuously at the proper rate, with the tool in position D_1, it is evident that it will cut out in the wheel a suitable form for that portion of the worm with which it coincides. If the tool blade be shifted to D_2, and be rotated with the wheel as before, it will evidently at this point further shape the wheel to agree with the portion of the work with which it now coincides. The same may be said when the tool is shifted to D_3 or any other location in which it coincides with the thread of the worm. Evidently, in order to make the teeth which this tool cuts absolutely match the worm, it is only necessary to have it revolve with the work at the proper rate and be advanced meanwhile helically on the thread of the imaginary worm from one end of it to the other, so that it successively

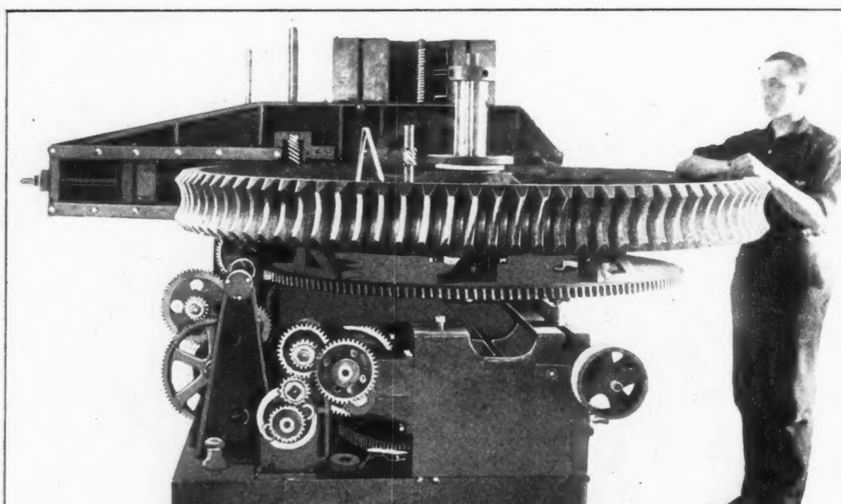


Fig. 3. Eberhardt Bros. Worm-gear Generating Machine, Involving the Principle shown in Fig. 2.

coincides with every portion of the thread surface of the worm.

This is what is done in the machine shown in Fig. 3. The cross rail in the rear of the machine carries a boring bar with a single-bladed tool in it, shaped to match the outline of the worm which is to be used with the wheel. This spindle and the blank are revolved together. The tool meanwhile, starting to the left-hand end, is fed helically along in the direction of the thread of the worm which it represents. This movement is accomplished by a train of differential gears which shift the spindle endwise and give it at the same time a forward rotary motion, independently of the train of gearing connecting the spindle with the work arbor. For details as to this the reader should refer to the article previously mentioned.

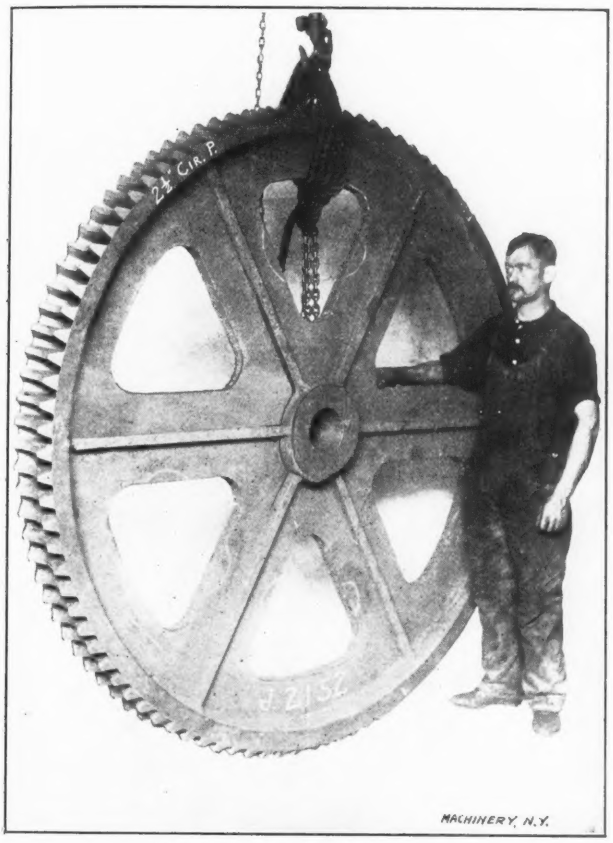


Fig. 4. The Completed Worm-gear.

The wheel shown in place in the machine in Fig. 3 and completed in Fig. 4 is believed to be the largest one ever made by this process, in this country at least. It has a pitch diameter of about 78 inches, with 98 teeth of 2½-inch circular pitch. It has a face 7½ inches wide, for a worm 10¾ inches outside diameter. The wheel blank weighs 3,150 pounds. It was made for a Western contracting firm, and is intended for some form of machinery used in the beet sugar industry.

For this large wheel, the work spindle is not rotated by the usual means provided for smaller ones; instead a face-plate drive is used. As shown, this face-plate has worm teeth formed on its periphery, and through these the rotary motion is transmitted to the work. Although this job is a large one, it does not tax the machine to the utmost, either in dimensional capacity or in driving power. As the other extreme of its range, a small worm-wheel shown standing upright on the rim of the work in Fig. 3, is interesting. This "wheel" is of the kind sometimes used for spindle drives in gear-cutting machines, in which the worm is considerably larger than its mate. This accounts for its peculiar appearance. These two parts together indicate the great range of usefulness which this process of cutting possesses, owing to the fact that the question of hobs is not the determining factor.

* * *

The parting sand used by the molder to prevent the sand in the cope and nowel sticking together is simply the burned sand scraped from the surface of castings.

FAULTS OF IRON CASTINGS.—1.

POINTS FOR THE MACHINE DESIGNER.

FORREST E. CARDULLO.*

Forrest E. Cardullo.†

The most useful and indispensable of all the materials with which the designer has to do, is cast iron. Of all the metals used in the construction of machinery, it is the cheapest. It is the one to which we can the most readily give the form and proportions which we desire. It is, of all the common materials, the most easy to machine. While it is lacking in strength and ductility, its cheapness makes it possible to use it in such ample quantity as to overcome these disadvantages, and in many constructions it may be so shaped and proportioned, or so reinforced by other materials, as to make this lack but a slight detriment. It is therefore a matter of interest to the designer to learn of the various faults to which this valuable material is subject, and the best ways in which they can be avoided or minimized.

Causes of Blow-holes.

Probably the one fault which spoils more castings than any other, is the result of an outrush of gas from the materials of the cores or the mold, into the molten iron, at the instant of solidification. If the solidification of the iron has proceeded so far that the outrushing gas or steam cannot bubble through it, and escape through the vents which should be provided for the purpose, it will be imprisoned in the substance of the casting, forming one or more holes, according to the special shape of the casting, and the quantity of the escaping gas. These holes, which are known as blow-holes, may not be apparent on the outside, and quite often occur in such a location that they do no particular harm, but it is more often the case that they occur at some point where they become apparent when the metal is being cleaned, or where their presence weakens the casting greatly.

Steam from Moisture in Sand.

The gases which cause blow-holes may come from three sources. They may be, and generally are, caused by the generation of quantities of steam from the moisture contained in the molding sand, by the heat of the iron. In the case of dry sand and loam castings, the quantity of steam so generated is so insignificant, if the molds have been properly heated, that it gives no trouble whatever. In the case of green sand castings, however, the moisture present, and therefore the steam generated, is quite large in amount, and special precautions have to be taken to prevent blow-holes.

When the molten iron pours into a green sand mold, all the moisture in the layer of sand immediately in contact with the iron will at once be transformed into steam. The depth of the sand layer so affected depends on the thickness and extent of the fiery mass to which it is adjacent. The steam so formed must either force its way through the molten iron in the form of a mass of bubbles, or else it must escape through the sand. To facilitate its escape, the mold is vented. That is, after the damp sand has been packed around the wooden pattern by ramming it closely into place, a wire is thrust repeatedly into the mold, making numerous passages for the escape of the steam and gas.

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It is obviously impossible that one of these vent-holes should extend to every point in the layer of sand adjacent to the casting, so it is necessary that the most of the steam and gas should force its way for some small distance through the sand, before it can reach a vent-hole. This it can only do when the sand is somewhat porous. If the sand is too tightly rammed, it will lack the necessary porosity, and even though it be unusually dry, and the venting carefully done, the casting will be full of blow-holes. I have known of cases where molds have been rammed so hard that the castings were nothing better than shells, the whole interior being a mass of blow-holes.

Decomposition of Binder in Cores and Entrapping of Air.

The second cause of blow-holes in iron castings is the decomposition of the material, generally flour or molasses, used as a binder in preparing the cores, and its escape in the form of gas, into the iron, at the instant of pouring. It is impossible to prepare and bake a core in such a way that it will not give off large quantities of gas when the iron is poured, and so means must be provided for the escape of this gas. In order to do this, the cores are prepared with wax strips running through them. When the core is baked, the wax melts, leaving passages for the escape of these gases, known as core vents. If the core is of such form, and so set in the mold, that the gases can escape from these vents in an upward or sidewise direction, and leave the mold without forcing their way through the molten iron, no blow-holes will result.

A third source of blow-holes is the entrapping of air in certain parts of the mold, and its mixing, on expansion, with the iron. This trouble is due to insufficient venting of the mold, and is not a fault to which the designer need pay any particular attention.

Dry Sand or Loam Advisable for Large Complicated Castings.

In the case of large and complicated castings, it is generally advisable to make dry sand or loam castings, in order to avoid, as far as possible, the chance of blow-holes. When the mold is very large, it is difficult to vent it thoroughly, and when the work on it extends over a period of three or four weeks, it is impossible to keep the vents from filling up; hence the general use of dry sand work for large castings. Often, however, for the sake of economy, fairly large and complicated pieces must be undertaken in green sand, and it becomes a matter of importance that they be so designed that the molder will not be compelled to invite disaster by keeping his sand too wet, or ramming it too hard, and that there is no part of the mold which may not be thoroughly vented.

Elements of Green Sand Molding.

In order that we may understand thoroughly the effect of the design of a casting on the probability of blow-holes, it is necessary that we review in a brief way, the elements of green sand molding. The sand is sprinkled with water, and thoroughly mixed and sifted, preparatory to packing, or "ramming" it around the pattern. The object of wetting the sand is of course to cause it to stick together when it is packed. Up to a certain point, the wetter it is, the better it will stick, but the molder should not wet it any more than is necessary. In the same way, the more tightly the sand is rammed, the better its particles will cohere, and the more easily will the mold be handled, and the pattern drawn. However, tight ramming and wet sand, while they make a solid and easily handled mold, invariably produce blow-holes, and are therefore to be avoided.

It will be apparent then, that if a pattern be of complicated form, or hard to draw, or if when it is drawn it leaves the sand in such a form that the mold will easily fall together at a little jarring, the molder will be compelled to wet the sand more, and to ram it harder than usual. Small deep openings, sharp fillets, and thin walls and partitions of sand, are especially troublesome. Not only do they make it difficult to draw the pattern, and handle the mold, and so make excessive wetting, and hard ramming imperative, but they make spots in the mold which the venting wire is unlikely to reach. For these reasons, they are to be avoided when possible, in any class of molding, whether it be green sand, dry sand, or loam work, and on no account should such work be permitted in the case of large green sand castings.

When designing a casting to be made in green sand, the designer ought to know the position which it will occupy in the mold, when it is poured. In general, the parts of a casting which lie in the bottom of the mold will be the soundest, and those parts which must be machined, or which require the greatest strength, should therefore occupy the bottom of the mold, if possible, when the casting is poured. Having decided which side will be down, the designer needs generally to pay no particular attention to the configuration of the lower part of the mold, provided only that all of the pattern can be drawn, and that there are no sand partitions which overhang, or whose extent is large in proportion to their thickness. To insure a sound casting, the sand in the lower parts of the mold must be comparatively dry, and loosely rammed. This condition of affairs is not generally hard to attain, since all the work on the sand is done with the pattern in place, and that part of the mold is not generally moved or handled after the support of the pattern has been withdrawn. In the lower part of the mold, the sand is generally supported at all points in a very thorough manner by the sand lying under it, and so hard ramming or wet sand is unnecessary. If, however, the pattern must be made with loose pieces, or with sharp fillets, or must leave thin walls or tongues of sand when it is withdrawn, the case is changed. Then hard ramming and wet sand are almost compulsory, and the molder is not to be blamed if he does not produce sound green sand castings. The fault is with the designer.

The upper part of the mold must of necessity be rammed harder than the lower part, since the sand is not supported from beneath, but hangs from above. This is not as great a disadvantage as it might seem to be at first sight, since the escaping gases do not have to make their way through the iron, as they would if they were given off by the sand in the lower part of the mold. The venting, however, must be just as thorough, and it is desirable that the sand should be as dry as possible. The whole arrangement of the upper part of the casting should be such that the sand may be well supported from above. Generously rounded fillets and corners, simple surfaces, plenty of "draft," and an absence of depending walls and masses of sand, make the mold easy to handle, and therefore promote freedom from blow-holes.

When Green Sand and Dry Sand Both may be Used.

It often occurs that the larger part of a casting is of simple form, and easy to mold. A certain part of it, however, may be of a form exceedingly difficult to mold, and therefore likely to give a good deal of trouble. It is not necessary that the whole casting should be made in a dry sand mold, but a core-box may be made to take care of the difficult part of the work, even though the work would ordinarily be done without a core. It is just as easy, and often just as desirable to cast the external face of a casting against a core, as the internal face. While it may not pay to do this if only one casting is wanted, if a great many are wanted, it is often the cheapest possible way of making them, and reduces to a minimum both the work of the molder, and the chance of a spoiled casting. Often forms may be cast in this way which could not be attempted in any other. If it is desirable to use this method of working, the designer has it in his power to make the construction of the core-box much simpler and cheaper than it might otherwise be, by giving the matter a little thought.

Support of Cores.

In arranging the coring of a mold, it is always better, if possible, to support the cores at the top. The gases formed in the core, being light, tend to rise, and if the core is supported at the bottom only, they tend to escape into the iron, and to bubble through it. If they can escape at the top, they will pass off without coming in contact with the iron. When it is impossible to support the cores at the top, they should be so arranged that the gases can pass off at the sides, and escape from the mold without coming in contact with the iron.

CUTTING BEVEL GEARS WITH A ROTARY CUTTER.*

H. P. FAIRFIELD.†

Pictures are a great help in understanding a machine shop operation. It is often possible, with a few half-tones, to convey ideas that would require many pages of written matter to express them. In the following article advantage has been taken of this facility of the photograph to express ideas, so that a long story has been told in comparatively few words.

While the process of forming the teeth of a bevel gear by milling them with a rotary cutter, is not easy to describe without telling how to make a drawing of the blank, it seems best to leave the designing and drawing for another article. The average apprentice approaches the problems of the machine shop with hardly enough knowledge of the art of making drawings to enable him to read them, to say nothing of making them. It is to be hoped that the day will come when a boy may be given an opportunity to master some things of both sides of his life work.

The Drawing.

Fig. 5 represents the drawing of a bevel gear and its pinion, as it is given to the workman. It is to be noted that draftsmen are not all bound by the same conventions, but this drawing is as it would be made by at least one large firm who cuts many bevel gears. All dimensions other than those necessary to our description have been omitted to avoid confusion. The description will, therefore, be confined to those operations bearing upon the subject at hand, and will show what, in the writer's estimation, should be the best order of operation to insure accuracy, convenience, and speed. In machining the blank to the required angles and dimensions, use is made of an engine lathe fitted with a compound tool-slide, and the tooth-cutting operations are made in a milling machine fitted with a universal index head, with graduated dials on its feed screws.

In the drawing Fig. 5 are figured the angles needed to shape up the blank, and those needed when cutting the teeth. Those angles which are to be worked out in the lathe, using the compound slide, are figured from the line normal to, or at right angles to, the center line of the blank. Figured in this way, they conform to the graduations on the compound slide of the lathe, and all calculations by the workman in the shop are avoided. The cutting angle is figured from the center line to conform with the graduations upon the milling machine. The diameter of the gear, as drawn, is 6.18 inches, and operation No. 1 is to size the blank to this diameter. While some draftsmen in bevel gear work give the outside diameter to thousandths of an inch, the nearest hundredth is sufficiently accurate.

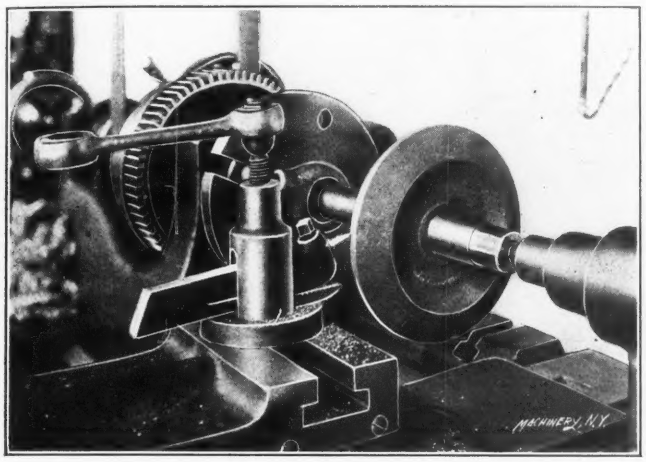

Fig. 1. Sizing the Outside Diameter of the Blank.

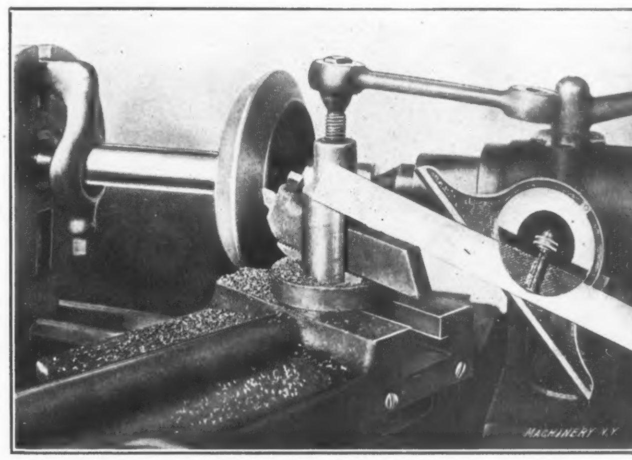

Fig. 2. Turning the Face.

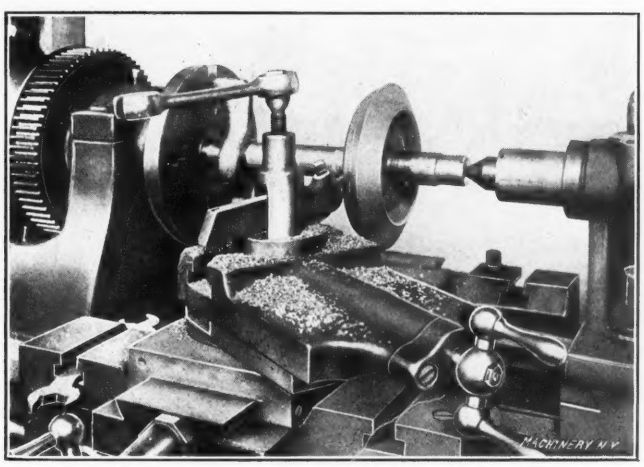

Fig. 3. Turning the Outer Edge.

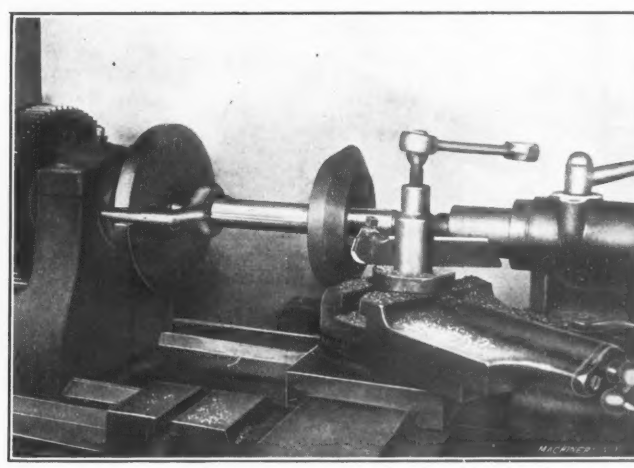

Fig. 4. Turning the Inner Edge of the Teeth.

Turning the Blank.

Fig. 1 shows operation No. 1, sizing the outside diameter, which leaves a flat surface easy to caliper.

Operation No. 2, shown in Fig. 2, is the turning of the face angle. As figured on the drawing, this angle is 31 degrees, and the compound slide, as shown in the cut, is set to conform to this. In setting the slide, the nearest quarter degree is all that is needed. A sufficient amount of stock is removed by this operation to leave a well-finished surface for the tops of the teeth.

Fig. 3 shows operation No. 3, which is the forming of the back angle, or angle of edge. As figured, this is 56 degrees 20 minutes, and the compound rest is reset to read to the required angle. In this operation, sufficient stock is removed to bring this surface up to an edge with the one previously formed. Note that in all the operations the tool is adjusted normal to the surface operated on, to obtain the maximum cutting efficiency.

* The following articles relating to the calculation and cutting of bevel gears have been previously published in MACHINERY: Cutting Bevel Gears with Correct Teeth, and Cutting Bevel Gears, June, 1898; Gearing, March, 1902; Proportion of Gears, May, 1903, engineering edition; Use of Diagrams and Tables for the Solution of Problems in Gearing, March, 1904, engineering edition; An Automatic Gear Cutting Machine, July, 1905; Bevel Gear Chart, September, 1905; To Calculate the Center Angles of a Pair of Bevel Gears, having their axes at other than Right Angles, June, 1906; Bevel Gear Formulas, May, 1907, engineering edition.

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Fig. 4 shows operation No. 4, the finishing of the inner ends of the teeth. As these are parallel to the outer ends, the compound slide remains as set for operation No. 3. Sufficient stock is removed to make the teeth of the required length as figured (that is, 1¼ inch), and an ordinary steel rule obtains this measurement with sufficient accuracy. Filing or scraping the surfaces puts the blank in readiness, so far as the teeth are concerned, for the milling operations. If the performed oper-

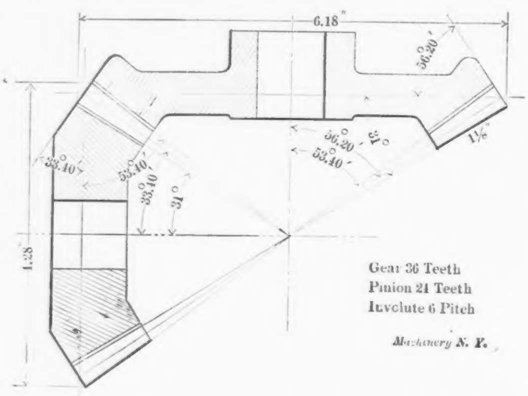

Fig. 5. Essential Dimensions of the Gear to be Cut.

ations have been done on a reliable lathe, and care has been taken in reading the figures on the drawing and the graduations on the compound slide, the blank must agree with the drawing. It is well, however, to check the angles with a protractor, and Fig. 6 shows this. While the blank and the tool would ordinarily be held in the hands when making this test, for convenience in photographing they are placed as shown.

With the drawing figured as shown, and the operations followed as numbered, it will be noted that so far the greatest simplicity has resulted in the setting of the machine and in the measurements made.

Selecting the Cuttter.

The tooth cutting operations are made in the milling machine, but the points to be brought out will apply to gear-cutting machines as well, with slight modifications due to the different mechanism. There are in use at least four different methods by which the machines may be used to form the teeth, and as all bevel gears cut with a rotary cutter must be in error, some latitude as to means can be allowed the workman. For the pair of gears shown, the diametral pitch at the large end of the tooth is 6, since the gear has 36 teeth or 6 teeth for each inch of the largest pitch diameter. At the

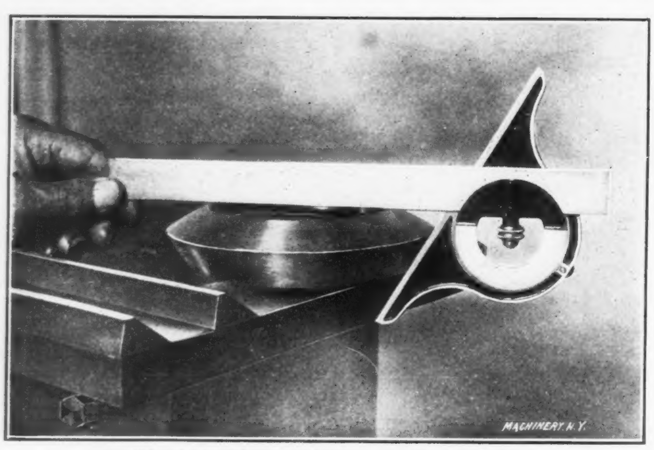

Fig. 6. Testing the Accuracy of the Angles.

inner end of the gear the pitch diameter is much less. The number of teeth is the same, however, and thus the pitch is finer; or, in other words, there are a greater number of teeth per inch of pitch diameter. Suppose, for example, that the pitch diameter at the inner end of the teeth is four inches, the number of teeth per inch would be nine, and the pitch is therefore nine, or, as it is commonly written, 9 P.

In choosing a cutter with which to form the teeth, it will thus be seen that if it is the right pitch for one end of the teeth, it must be in error for the other, and it is for this reason that all bevel gear teeth cut by milling are at the best a compromise for the true shape. As noted above, there are four methods of compromising, but the one chosen for illustration is that usually termed the "rolling method," meaning that the gear is rolled to and fro for adjustment with the cutter.

To choose a cutter for spur gear cutting, the pitch and number of teeth being given, is a simple matter if Table I,

TABLE I. RANGE OF CUTTERS IN STANDARD INVOLUTE SERIES.

No. 1	will cut wheels from	135 teeth	to a rack.		
" 2	"	"	55 "	134 teeth.	
" 3	"	"	35 "	54 "	
" 4	"	"	26 "	34 "	
" 5	"	"	21 "	25 "	
" 6	"	"	17 "	20 "	
" 7	"	"	14 "	16 "	
" 8	"	"	12 "	13 "	

taken from the catalogue of the Brown & Sharpe Mfg. Co., is used. To choose a cutter for milling bevel gears, however, the method given below, and illustrated in the diagram, Fig. 7, is used. Instead, then, of taking a cutter for the number of teeth which you wish to cut, it may have to be for a much larger number. While this rule is not universally followed and has its limitations, it covers most cases better than any other with which the writer is familiar, and a cutter chosen by this method is the correct curvature for the teeth at the extreme large end, though it cannot have the right curve, for the rest of the tooth. It must, also, be so

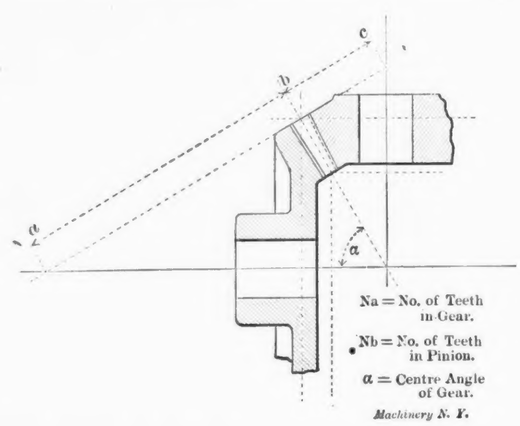

Fig. 7. Diagram showing Method of Selecting Cutters for Bevel Gears.

chosen as to be at least as thin as the width of space at the inner end of the teeth. This makes it necessary to use special cutters, somewhat thinner at the pitch line than those used for spur gears.

Measuring the dimension in the drawing, Fig. 5, which corresponds to the line $a\,b$, Fig. 7, and doubling it, gives a length of 10¾ inches, nearly. This dimension is not indicated in Fig. 5. Multiplying this by the pitch, makes the number of teeth for which the cutter must be chosen, sixty-four plus. In Table I, a No. 2 cutter is listed to cut from 55 to 134 teeth, and is the one selected. When it is inconvenient to measure the back cone radius, use is made of the following formulas, taken from Brown & Sharpe Mfg. Co.'s catalogue.

$$\text{Tan}\ \alpha = \frac{N_a}{N_b} \qquad (1)$$

$$\text{No. of teeth to select cutter for gear} = \frac{N_a}{\cos \alpha} \qquad (2)$$

$$\text{No. of teeth to select cutter for pinion} = \frac{N_b}{\sin \alpha} \qquad (3)$$

If the gears are miters, or alike, only one cutter is needed. If one is larger than the other two cutters may be needed.

Setting Up the Work for Trial Cuts.

The cutting angle of the gear is 53 degrees 40 minutes, figured from the center line of the gear, which corresponds to the center line of the index centers. The center head is therefore swiveled in the vertical plane to the position shown in Fig. 8, or through an arc of 53 degrees 40 minutes by the graduations. The cutter is placed in cutting position upon

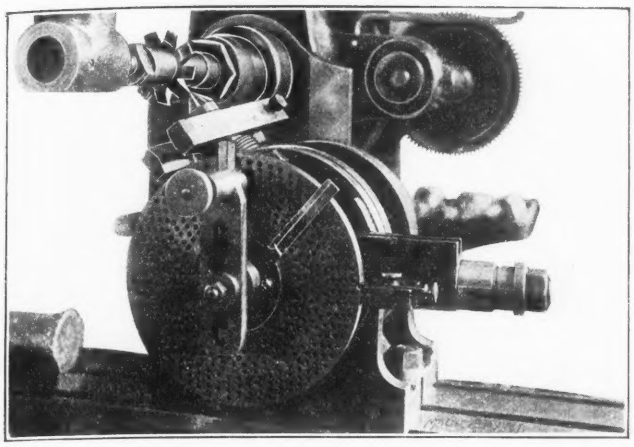

Fig. 8. Spiral Head Set for Proper Center Angle and Indexing.

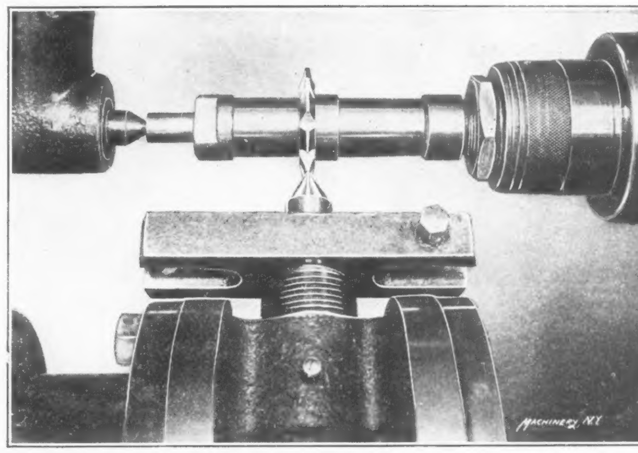

Fig. 9. Setting the Cutter Central with the Work Spindle

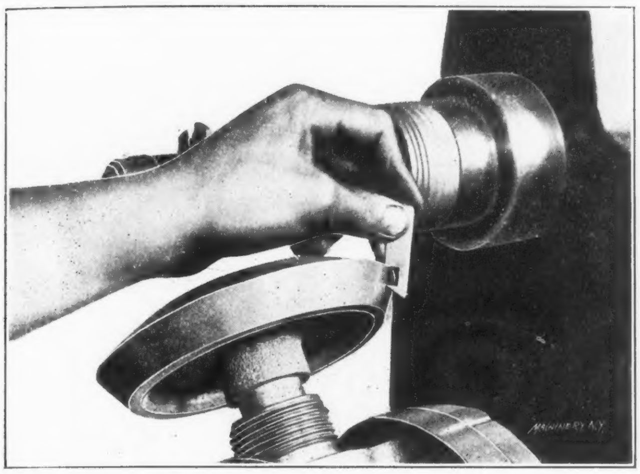

Fig. 10. Marking the Depth of Tooth with Depth Gage.

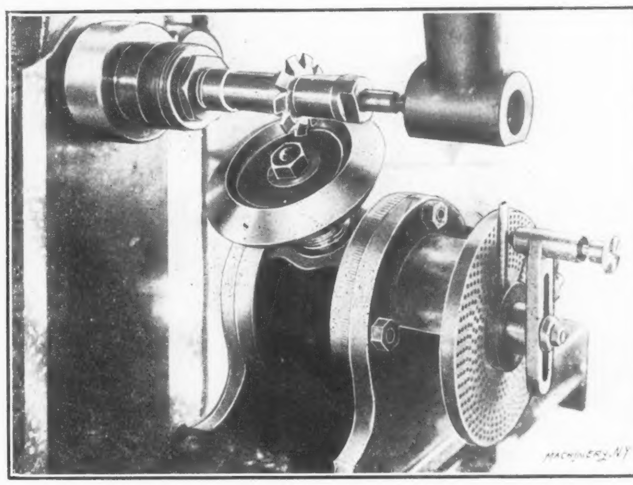

Fig. 11. Work in Place on Machine, Ready for Trial Cut.

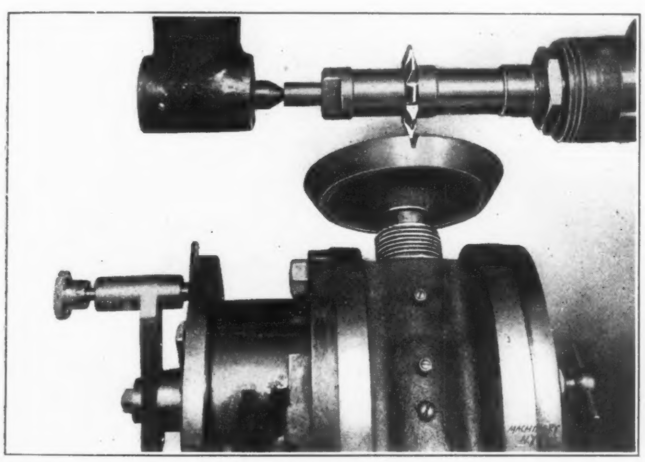

Fig. 12. Trial Cut Completed.

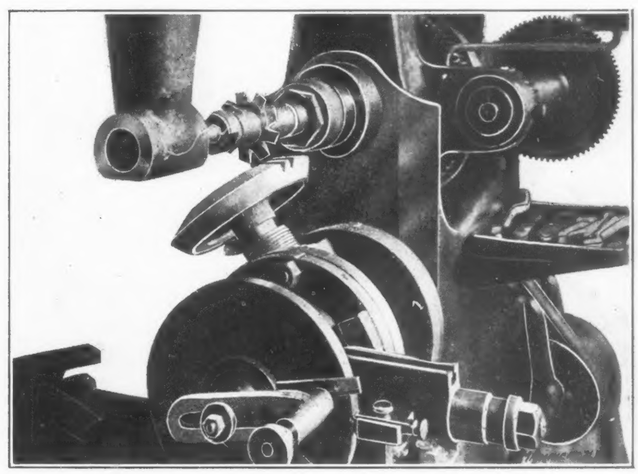

Fig 13. Trial Tooth Formed by Two Trial Cuts.

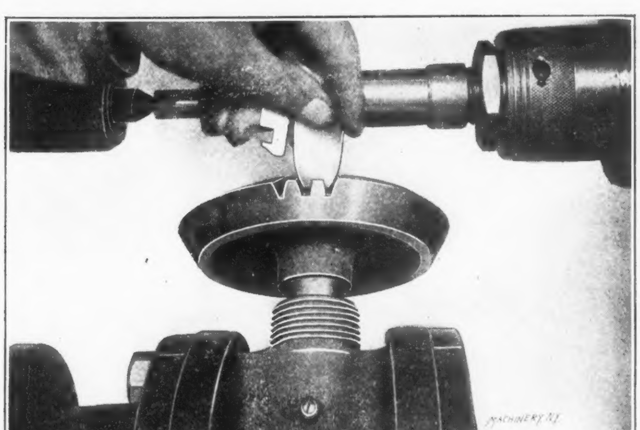

Fig. 14. Testing Accuracy of Settings for Approximating the Tooth.

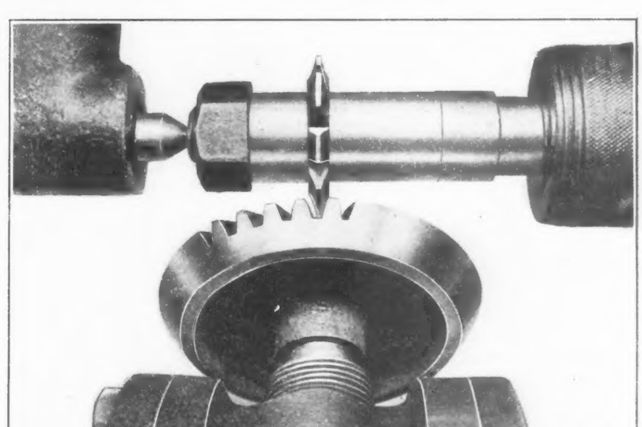

Fig. 15. Cutter Completing the Tooth, showing Widened Tooth Space.

the milling machine arbor, which must run true. Fig. 9 shows how the cutter and the index center are brought into alignment by adjusting the cross slide. Most makes of cutters have a center line scribed on the tops of the teeth, or on the back face, to set the center to in making this adjustment. Be sure that the center runs true. It is best to try it with a test indicator. The gear blank, as shown in Fig. 10, is mounted firmly on a special true-running arbor, with a taper shank to fit the index head.

Fig. 8 also shows the index pin and adjustable sector set for spacing thirty-six teeth on the blank. Although use can be made of the printed table which comes with the milling machine to learn the turns and parts of turns to make when indexing, a very simple calculation gives it, when the number of revolutions which must be made with the index pin to give the work a complete turn is known. In most milling machine index heads, this number is 40, as they have a 40-toothed worm gear and a single-thread worm; 40, then, is the numerator of a fraction, the denominator of which is the required spacing; or, in other words, dividing forty by the number of spaces required gives the number of turns and parts of a turn of the index pin. In this case, $40/36 = 1\,4/36 = 1\,1/9$ revolutions, or one turn and one-ninth of a turn. Six holes in the 54-hole circle is taken to give the one-ninth of a turn required. Any circle of holes evenly divisible by nine, can, of course, be used.

Fig. 16. Cross-feed Dial when Work Spindle is Set Central.

Fig. 17. Cross-feed Dial Set for Cutting Outer Side of Tooth.

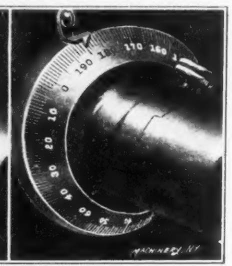

Fig. 18. Cross-feed Dial Set for Cutting Inner Side of Tooth.

With the blank set to the required cutting angle, the next step is to make a line on its back edge showing, as in Fig. 10, the depth of the teeth at this point. This is done with a "depth of gear tooth" gage of the proper pitch. Such gages may be bought in different sizes for different pitches. Be careful to hold it parallel to the back edge of the blank when scribing the line.

Fig. 11 shows the machine and work completely set up, and adjusted for the trial cut. This cut must not be so carelessly made as to be deeper than the tooth depth line marked out in Fig. 10, and several trial cuts, each deeper than the other, may well be made in getting the required depth for the first space.

Approximating the Correct Tooth-form by Rolling.

Fig. 12 shows the first space cut to depth. The work is then indexed for another cut. Fig. 13 shows the trial tooth left by the two trial or central cuts. It is noticeable that the tooth is much wider on the pitch line than it should be, at the outer end. This may also be true of the inner ends at the pitch lines, and is certain to be true of the inner ends above the pitch line when the gear is finished, unless this part of the tooth is afterward filed somewhat. The coarser the pitch and the longer the tooth face, the more this latter shows. The rolling method of approximating the true tooth shape starts by making several central cuts, such as shown in Fig. 14, giving teeth which may be used to test adjustments by as they are made. With the cross feed index set at zero, the table is moved off center *toward* the column of the machine a trial distance, and then clamped immovably. By means of the index pin, the work blank is rotated or "rolled" back toward the cutter again to just admit it to the space at the inner end of the teeth. Do not disturb the adjustable sector when doing this, but leave it to mark the hole which is correct for the central position.

Rolling the gear is equivalent to swivelling the tooth about the apex of the cone, and allows the cutter to take a heavier shaving or chip at the outer end of the tooth than it does at the inner end. The greater the adjustment off center and the more the blank is rolled, the greater this difference.

If, for example, the cutter leaves the trial teeth accurate in thickness at their inner ends, the blank would be rolled, when making adjustments, to allow the cutter to just enter the trial cut at that end without thinning the teeth. Exceptions to this will be noted further along.

After the trial cut has been taken upon one side of the tooth, the index pin and the cross slide should be returned to their original central position, and the blank indexed one tooth, to bring the cutter upon the side opposite to that already thinned off. Afterward set the cross slide off center *away* from the column and roll the blank toward the cutter again, the same amount as before, until the cutter just enters the space at the inner end. Thin off this side. If the larger end of the tooth is still too thick, it shows that the cross slide was not set off from its central position a great enough distance, and another trial cut must be made on each side of the tooth, carefully duplicating the operations just noted, but giving additional movement to the cross slide and the rolling of the blank, repeating this until the gage shows the right thickness at the outer end of the teeth as in Fig. 14. The gage shown is one of a form common in gear cutting practice. The notch in the end of it has a depth equal to the addendum, and a width equal to the tooth thickness, of the pitch for which it is intended—6 in this case.

As previously stated, all this has been done on the supposition that the thickness of the cut left the space and teeth at their inner ends the right width. If the cutter is too thin to do this, the teeth must be shaved on their sides at the smaller as well as at the larger ends. It is then necessary to observe that neither end is cut too narrow, and the cross-slide adjustments, as well as the rolling of the blank, must allow for shaving the tooth its entire length.

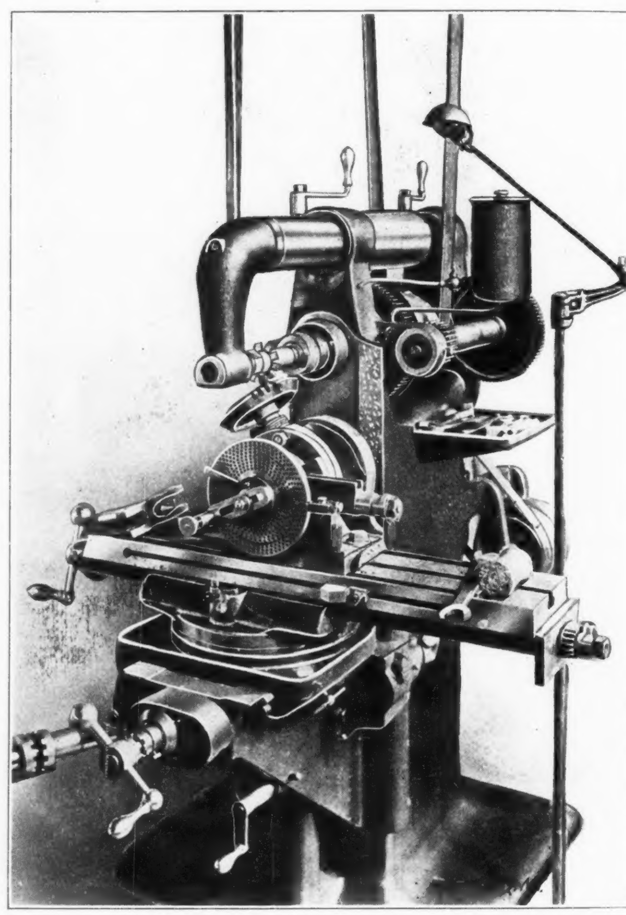

Fig. 19. General View of Machine as Arranged for Cutting Bevel Gear.

In the gear shown, the cutter was considerably thinner, and the tooth was shaved its entire length. In making the trial cut, the cross slide was offset 0.010 inch, and the blank rolled four holes in the 54-hole circle, and the trial tooth shaved upon both its sides. These amounts were afterward increased to an offset of the cross slide to 0.015 inch each side of the zero line and seven holes in the 54-hole circle. This gave a

tooth that gaged up as desired at its inner and outer ends on the pitch line.

If the teeth of the pinion are not to be filed at their inner end above the pitch line to bring that portion of the tooth more nearly to shape than the cutter will leave it, it may be necessary to widen the space at the inner ends of the gear to give additional room. On the finer pitches, the cutter leaves the teeth so nearly correct that they need not be filed; but in the coarser pitches, filing is quite necessary.

Cutting the Teeth.

Having established the amount off center, and the angle to roll the blank, proceed to cut the rest of the teeth. If the pitch is rather coarse, three cuts may be necessary all the way around each blank. In the finer pitches, however, two cuts around are sufficient. In the case of three cuts, the first is a central cut made as already shown, with the standard cutter, all the way around, and then the two thinning cuts follow. Some gear-makers use a so-called "stocking cutter" in making the central cuts, afterward thinning the teeth with a standard cutter as noted. This undoubtedly leads to less sharpening of the standard, and therefore, less wear.

If the pitch allows two cuts around the blank to be sufficient, the first is, of course, made with the table offset and the work rolled to shape one side of the teeth, and the second, with the machine and work set to shape the opposite side, each cut going all around the blank.

Figs. 16, 17 and 18 show the cross-feed screw index dial, as adjusted for the central cuts, and afterward the thinning cuts.

Fig. 15 shows the amount that the space is wider than the cutting edge of the cutter; and Fig. 19 is a general view of the entire machine as set up.

General Directions.

In closing, it may be well to note some precautions: Mounting the work as shown, with all "overhangs" as short as possible, still leaves the outer end unsupported. Care must therefore be taken to have the taper arbor in the index head well fitted and driven firmly in place; the work must also be mounted upon the outer end of the arbor so that it will not slip under the action of the cutter.

The cutter must be carefully ground sharp, with each cutting edge radial and exact, relative to the center hole. The cutter must also be in coincidence with the center line of the index centers or the teeth will "hook," relative to the apex of the cone as well as to the radius.

In making adjustments of the cross-slide or with the index pin, see that the final motions are always in the same directions. This prevents errors of adjustment due to lost motion or backlash. For example, in Fig. 17 the zero setting was made by moving the cross-feed handle to the right until the dial read to the zero mark. That shown in Fig. 18 was a continuation of this motion, and in Fig. 19 the handle was reversed at least a half revolution, and then turned in a right-hand direction to the required graduation. All milling machines and index heads are provided with means of clamping the several slides and swivels, and these should always be tightened while the cut is being made, and, of course, loosened when adjusting. After the indexing for a cut, place the counting sector in readiness, as shown in the cuts, for the next adjustment.

In turning up the blanks, machine an extra one to use as a "dummy" for setting the machine. This dummy may be used until cut up. Finally, settle upon a regular order of operations, follow it until a habit is formed, and fewer errors will result.

* * *

Prof. Battle, of London, stated in the course of a recent lecture that it is believed that American roller press flour is a prime cause of the great increase of appendicitis noted since its introduction throughout the world. He claims that particles of iron are found in the appendix concretions, etc. Unfortunately for Prof. Battle's theory, machinists show no greater susceptibility to appendicitis than people engaged in other occupations, and surely the machinist swallows a much larger quantity of iron dust every day, while in the machine shop, than he ever gets in the bread he eats.

EXAMINING AND TESTING FILES.*

OSCAR E. PERRIGO.†

In discussing the question of files and their qualities, it may not be out of place, and it should certainly be of interest, to consider briefly the properties of files in general, and more particularly, the characteristics of good files.

While a file is one of the oldest and most ordinary tools of the mechanic, and one with which every machinist is supposed to be perfectly familiar, it is yet the one tool about which the average machinist knows the least, when the fundamental principles of its construction and operation are considered, and with which he is usually less efficient than with almost any tool he uses. In former years this last condition did not exist in nearly as great a degree as at present, for the reason that hand tools were used to a far greater extent. Apprentices were early taught their proper use, and in time became very expert and efficient, particularly with the cold chisel and hammer and the file. It has been well said that "the range of usefulness of a good file is only limited by the skill and efficiency of the operator."

Although the file is one of the oldest tools, it is one whose simple design and primitive construction has seemed to defy all attempts to improve it, except in the form of its teeth

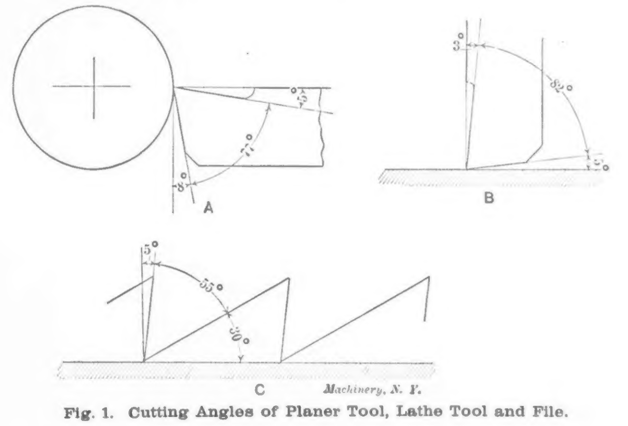

Fig. 1. Cutting Angles of Planer Tool, Lathe Tool and File.

and the methods of its manufacture. Machines have been invented to do much of the work of file-making, which was formerly performed by hand, but still many thousands of files are annually made by the same primitive hand methods that were used hundreds of years ago—the cold chisel and hand hammer. In fact the file that is mentioned in the Bible (1st. Sam. 13 : 21) was probably made in substantially the same manner.

Characteristics of the File.

The file, like many other tools, has three distinct and important characteristics, which demand attention of the manufacturer, the buyer and the user, if quality is to be taken into account, namely: first, the quality of the steel of which it is made; second, the form of its teeth, no matter whether cut by machine or by hand; and third, the temper, no matter by what process it has been hardened.

The first of these questions, the quality, and hence the price, of the steel used, should cut as little figure in producing a really good file as in producing any other good tool. Yet there is more than a suspicion, from the most casual and superficial test, that there is a great deal of poor steel used in the manufacture of files.

The form of the teeth, as will presently be shown, may vary considerably in different specimens, or they may appear in an ordinary examination to be very nearly alike, but when it is considered how little variation there may be between the teeth of a good file and those of a comparatively worthless one, this point assumes much importance.

The tempering of files is another process in which much ingenuity and study may be profitably employed. A good process, properly applied, may almost save a poorly made file and produce a fairly efficient one, while a poor or defective process, or one inefficiently handled, will ruin a file

* For further information regarding testing of files, see MACHINERY, February, 1898, The File and Filing; March, 1898, The Bite of a File.

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of excellent material and, so far, of good workmanship. The tempering should be so performed as to produce *hard*, and at the same time *tough*, teeth, and as nearly as possible *uniformity* of temper over the entire surface of the file, from heel to point.

The essential features and characteristics of files, to which it is advisable to give attention, in a systematic examination and practical test of files of different lengths, forms and cuts, will now be taken up in regular order.

Correctness of Form of File Blanks.

With the exception of the edges of such files as are called "hand, or pottance," "equalling," "pillar," and a few special forms, having the same width through their entire length, there should be no absolutely straight lines lengthwise of a file. All these lines should be convex. The amount of this convexity on the sides of well-made flat, square, round and taper (triangular) files, is substantially 0.08 inch per foot, that is, a six-inch straight-edge placed on the file and touching it at the center will show a space of 0.02 inch open at each end. On the edges of such shapes as half round, crossing, knife, etc., this convexity will be about twice this amount. Special curved files are, of course, excepted. Distortion from these limits should be observed, and files having concave lines, short bends, etc., should be rejected, except when they are to be used on very ordinary or rough work.

Transverse surfaces, nominally flat, should be very slightly convex, more nearly straight on fine cut files than the ordinary kinds. Those having concave surfaces should be rejected.

Surfaces which should be the arc of a circle, such as half round, crossing, round, etc., may be tested for correct form by laying them into drilled holes of various diamters in a thin plate of iron or steel. It will be found that a cheaply made file will hardly ever conform to a true arc, but is liable to have flat places on its surface, which, when in use will not come into proper contact with the work.

Triangular files may be tested for form with a 60-degree thread or center gage, and the corners of square and flat files with a thin steel square.

It will be surprising to note the many inaccuracies that will be brought out by these tests.

Not only the *form*, but the *finish* of blanks should be examined. It will usually be found that American-made files have a finish much superior to that of imported files, in which will be found deep scratches and furrows that detract not only from the appearance, but the efficiency of the file, particularly of the finer qualities.

The blank must not only be *thoroughly* annealed, but it must be *evenly* annealed. If there are hard and soft spots, it is evident that, in the cutting, the chisel will sink deeper in the soft than in the harder portions, thus making an uneven cut and a file comparatively worthless, for good work.

Correctness and Uniformity of Teeth.

The variation in the number of teeth on the different sizes, shapes and cuts, as well as on files of different manufacturers, is very considerable, ranging in files of 14 inches long and shorter, from 20 to over 200 per inch. On ordinary machinist's files, made in this country, the following is a fair average, *viz.:*—bastard cut from 20 to 25 per inch; second cut, 30 to 40; smooth, 50 to 60; dead smooth, 70 to 80.

Of the finer files, whose grade of cutting is indicated by numbers, the Grobet Swiss Files are as follows: No. 0, 40 to 70 teeth per inch; No. 1, 75 to 88; No. 2, 58 to 104; No. 3, 100 to 130; No. 4, 120 to 160; No. 6, 200 to 220.

Of the American made files of similar shapes and sizes as the Grobet files: No. 0, 35 to 60; No. 1, 55 to 75; No. 2, 80 to 95; No. 3, 90 to 120; No. 4, 125 to 135; No. 6, 160 to 200. It will be noticed that there is more regularity in the American system of numbers than the foreign. There is yet room for an improvement, similar to that made in this country in the old time wire gages.

The form of the teeth is a matter of much importance. If we analyze the form and action of a file tooth, we find it to be a straight knife or cutter as, for instance, a broad lathe or planer tool, whose face angle (or top rake) and whose cutting angle (or relief) will determine the amount of pressure necessary to cause it to cut, and which frequently (in the planer tool) has its line of cut set at an angle to the line of motion (as a file tooth), to cause it to cut easier and smoother. If this cutting edge is very thin and sharp, it is evident that the necessary pressure is very much reduced, while it may be so thick and with so little relief as to slide over the work, even under greatly increased pressure.

In the case of the file we have a large number of similar cutting edges, and consequently a proportionately large increase of pressure necessary to produce the desired effect. For this reason, and from the fact that the available pressure is greatly limited, the cutting edges must be comparatively thin and sharp, and the cutting angle (or relief) must be very acute. For instance, in Fig. 1, at *A*, is shown the proper angles for a lathe tool, and at *B*, those for a planer tool.

At *C* are given the ideal angles for file teeth. While these file teeth angles are desirable and would make an excellent file, they are not practically attainable mechanically. If the teeth of files were formed by a tool traveling parallel to their cutting edges we might produce any angle desired. But this is not practical. The teeth are formed with a rather obtuse angled chisel, which raises a portion of the metal above the surface being cut, as well as makes a depression

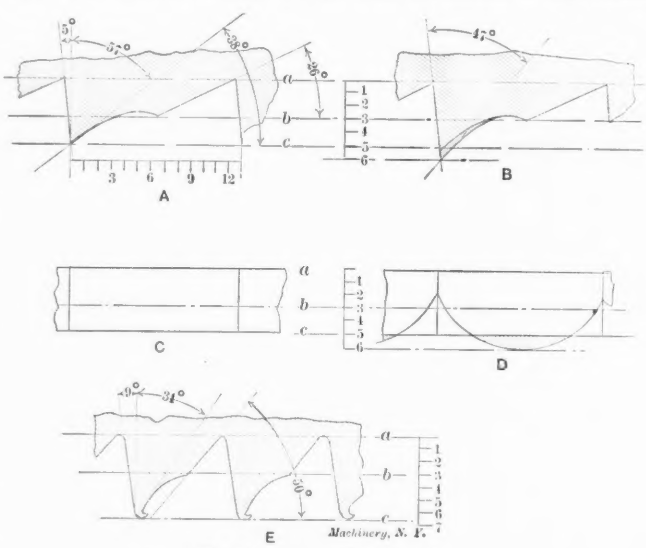


Fig. 2. Shapes of File Teeth.

below it. This action of the chisel produces the effect seen at *A*, Fig. 2, where *b* is the face of the blank to be cut; *a*. is the bottom of the cut, and *c* is the point of the tooth as thrown up by the cut.

It will be seen that the face angle instead of being 5 degrees in favor of a sharp edge, as at *C*, Fig. 1, and being able to cut with a lighter pressure, is thrown back 5 degrees from a vertical line, thereby losing 10 degrees. The cutting angle is rendered more acute, and, instead of the 30 degrees shown at *C*, Fig. 1, a tangent to the curve at the cutting edge shows 38 degrees, thus compensating to a considerable extent for the change of the face angle. At the same time, the angle of 55 degrees for the cutting edges, Fig. 1, becomes 62 degrees $(57 + 5 = 62)$.

There is one other element that enters into this condition and modifies it considerably. This is the cross cutting of the file. It may here be remarked that many mechanics fall into the error of supposing that the cross cutting *follows* the regular cut, while in fact it preceeds it, as a strong magnifying glass will readily show.

The influence of this cross-cutting is shown at *B* and *D*, Fig. 2. At *B* the darker shaded portion of the section of the tooth is due to the cross-cutting and when seen from the front causes the tooth to assume the rounded form shown in section at *D*, while in a single cut file the edge of the tooth would appear as a straight line, as at *C*. The cutting edge of a cross-cut file is quite thin, the angle being changed from 62 to 47 degrees, and it is this delicate but very useful, keen, edge that is soon lost by rough usage and too

much pressure on a new file, or by careless handling, allowing files to come into direct contact with each other. It is the custom with many manufacturers to reduce these sharp edges or points somewhat, either by a fine file or emery stick, or similar means before tempering, or by a sand blast in the cleaning process after tempering. One reason for doing this is that these fine points are not all of the same height and therefore give the file a tendency to "scratch" when first used. This is avoided by levelling them down. The better process is to use pulverized clay instead of sand in the cleaning blast.

At *E*, Fig. 2, is shown a cross-section of the teeth of a poorly cut file. In this case the angle of the edge of the cutting chisel is too acute, the pitch of the teeth is too short, the blow too heavy, and the consequent result is that the extreme points of the teeth are turned over in a "burr" which, by the tempering process, will necessarily be much harder than the thicker parts of the tooth, and will soon break off, as may be seen by standing with ones back to the source of light, holding the file on a level with the eye and looking lengthwise of it from the point to the tang, the broken points of the teeth being seen as small glistening spots or fractures.

In examining and testing files the pitch and form of the teeth will call for much careful attention, as much may be learned from their characteristics when viewed through a magnifying glass, which should not be over a half inch focus.

Uniformity of Temper.

There are various simple methods of testing a file for uniformity of temper that will readily suggest themselves to a mechanic, the most common being with the end or corner of a smooth piece of steel hardened very hard and not drawn to temper. This may be rubbed or drawn for a short distance over the file teeth at various points on the surface of the file, and the results examined with the aid of the magnifying glass. To one accustomed to such work the results will be very conclusive, the points of the file teeth being distinctly bent over where the temper is too soft.

Durability on Metals of Different Degrees of Hardness.

If we were to establish a file testing plant it would probably include, as an important factor, a filing machine particularly designed for testing the durability of files on different metals. In this machine provision would be made for a reciprocating motion of the file to be tested; a device for feeding the end of the metal to be filed up to the file; and a recording apparatus which would indicate, by a curved line traced upon a ruled sheet of paper, the number of strokes of the file, the amount of metal cut away, etc.

A machine of this character was constructed and used in Manchester, England, and described by Mr. Edward G. Herbert, who records some valuable data as the result. He claims to have found that with English files there was a great difference in the efficiency of the two sides of these files, amounting in some cases to 30 to 1. Judging from the many cases of distortion of foreign made files, their methods of tempering do not compare favorably with those in use in the United States, and this may account, to some extent at least, for such results. A difference in the efficiency of the two sides of a file has been often observed, but there is no record in this country of such results as Mr. Herbert has observed. Possibly it is for the reason that we can claim in file making as in many other mechanical processes, great improvements in the details of the work, and demonstrate in many respects the superiority of American products, including files.

In testing the durability of files by hand, comparative tests will, of course, have to be made by the same man, as no two men will handle a file exactly alike. Each file may be used for 500 strokes; then examined under the magnifying glass and the results noted. Then 500 strokes more, and again examined, noted, and so on until the file refuses to cut. The amount of metal filed away should be weighed carefully. These tests should be made on cast iron, wrought iron, soft steel, and steel hardened and drawn so that it will require a fairly good file to cut it at all.

By using pieces of half an inch square, containing one-quarter of a square inch area, and carefully measuring the length before and after each 500 strokes, the careful saving and weighing of the filings may be avoided. Either method may be rendered very instructive, exact and valuable.

Strength and Elasticity.

These two qualities may be tested at the same time. A convenient arrangement for holding files during these tests will be any kind of a vise with jaws in a horizontal instead of a vertical position.

These tests will consist essentially of clamping the tang in the vise and suspending known weights upon the point, noting the degree of flexibility for *elasticity*, and the weight necessary to finally break the file to ascertain the relative *strength*. A good file should bend to the extent of 5 degrees without breaking, and some will bend several degrees more. Those breaking at 2 degrees are too brittle for practical use. If long, slim files break at 3 degrees they should be rejected, as the workmen are likely to break them before they are half worn out.

This article has been prepared with a view to proposing only such methods as are easy of practical application, without any special or expensive apparatus being necessary.

* * *

RIFLED PIPE LINES FOR CONVEYING OIL.

A contract has been let by the Southern Pacific Company for the building of a rifled oil pipe line 256 miles long from oil properties in Kern County, in the southern part of California, to tide water on San Francisco Bay. An interesting feature of the line is the character of the pipe used, its "rifled" construction being a radical departure from that of lines now generally in use for conveying oil. Spiral indentations accomplished in the rolling of the pipe constitute the rifling. (See MACHINERY, February and July, 1906, engineering edition.) An exhaustive series of experiments has demonstrated that after a small per cent of water has been added to the oil, and the necessary pressure applied, that the whole will develop a whirling motion, and that the water being the heavier will seek the outside of the pipe, thereby enveloping the oil in a thin film or shell of water, this shell or film of water acting as a lubricant between the oil and the pipe, and thereby greatly reducing the friction and allowing the core of oil to glide through the pipe readily. Throughout the length of 256 miles of pipe there will be twenty-three pumping stations, the equipment of each station being in duplicate so that in the event of a breakage of any part of the machinery of one pump, the other may immediately be put into service. With the size of the pipe, which is 8 inches, and the high pressure carried, and improved facilities in every way, a rapid transmission of the oil has been shown to be possible, and it is estimated that at least 23,000 barrels of fuel oil can be delivered every twenty-four hours.

* * *

A POOR REASON WHY.

"The Creator made the ocean salt to save the land from putrefaction," etc.—*Marine Journal.*

This might be defined as an excellent example of reasoning that runs like a crab—backwards. The flora and fauna of the earth to-day are what they are because the conditions of environment, past and present, have been favorable to their development. If the ocean had been fresh there would have been, no doubt, an entirely different existing order of life, and then some would-be philosopher would have gravely remarked how fortunate it was that the ocean was fresh, etc. The author of the paragraph should take a half-hour course in the elements of world-making and evolution. He might as well assert that it is fortunate that the sun gives light or that rivers always flow through the valleys.

While the above is not precisely germane to the general character of MACHINERY, it was written for the purpose of emphasizing the need for clear thinking, which shall not confuse cause and effect. Perhaps in no business is it required more than in machine design and construction. The qualities that are required in the mental make-up of the designer enable him to quickly understand the absurdity of such reasoning as the above quotation, notwithstanding that many writers indulging in it have acquired some fame.

MAKING SWISS FILES IN AMERICA.—2.

In the September issue was published a description of the methods followed in the manufacture of files by the American Swiss File and Tool Co. of Elizabethport, N. J. Various operations were illustrated and described, leading from the cutting, forging and annealing of the stock, through the grinding and stripping operations, to the store-room, where the blanks await their turn to have the teeth formed on them.

The File-cutting Machines.

Those files which are to be machine cut are taken to the cutting room, located as shown in the plan Fig. 2. (See previous issue.) There was a noticeable absence of noise in this department, compared with what the writer has met with elsewhere; conversation was easily possible with everything going at full blast. Mr. Reichhelm attributes this freedom from noise to the care with which the foundations of the file-cutting machines were laid. They go down 2 feet below those of the building foundations. There is a row of these monolithic bases extending the full length of each side of the cutting room. Only about one-third of the space reserved for these machines is as yet filled. Fig. 7 is a partial view of that side of the room in which the equipment of machines has been completed. The curtains shown hanging from brackets on the wall are used to prevent cross lights, at times when the sun is shining in such a way as to offer difficulties on this score. In order to see just what he is doing, it is necessary for the workman to have the light shining on his work from the front.

Three designs of file-cutting machines are in use in this room. There are the original machines with which the business was begun, made by an American firm, the Hess Machine Co. of Philadelphia; then there is a German machine of quite different construction; and in Fig. 8 is a picture of one of the latest machines which have been installed. This embodies the results of the firm's experience with the two previous types. A file-cutting machine provides, essentially, means for striking a series of rapid blows with a suitably formed chisel to any desired depth, and means for feeding a file blank past the chisel at such a rate of speed as to give the desired spacing of the tooth.

The machine shown is driven by the belt and pulley at *A*. A cam is keyed to the driving shaft which, through a lever, raises the ram in head *C* against the resistance of the India rubber spring *D*, and allows it to fall again freely. The chisel *E*, held in the end of the ram, is thus able to deal a series of very rapid blows on the blank beneath it, the shaft revolving at a high rate of speed, and the cam having several lobes or teeth. The work *F* is laid on a holder *G*, resting on the inclined bed of the machine. It is fed along under the chisel, being drawn by a plate *B*, which is clamped between friction rolls at *H*. These rolls are driven at a uniform rate of speed, through gears and belting, from the main shaft of the machine. No provision is made for varying the spacing in a file, the makers believing that there is no virtue in the "increment" cut, but that there is a decided advantage in having the file uniform from end to end.

Fig. 7. General View of the Cutting Department of the American Swiss File and Tool Co.

The presser foot *J*, under the influence of a weight, follows the work just in front of the chisel and holds it firmly down to the holder *G*. The latter has a cylindrical bearing on a seat in the bed, so that on flat files the blank is free to adjust itself under the presser foot until the surface is parallel to the cutting edge of the chisel. In the case of half-round files, the holder is rocked by handle *K* to bring under the influence of the chisel any part of the surface desired. The distance between the work and the chisel may be altered by crank *M*, so the depth of cut may be varied at will. This is important, and much of the skill of the cutter lies in his adjustment for depth of cut. It is a vital requirement that the teeth be uniform from end to end. On a tapering file, such for instance as the flat side of a half round, a blow on the point of the file of the same force as that delivered in the middle section, where the blank is widest, would make so deep a cut as to almost sever the blank. The workman, then, in running from the point to the heel, starts in lightly, increasing the force of the blow by adjusting the crank *M* as

the width of the blank changes. The setting of the bed on an angle as shown, and the continuous feeding of the blank while the blows are being struck, has the effect of opening up the teeth as the chisel leaves each cut.

Etching of Teeth in Files.

Most mechanics are familiar with the idea of file-cutting with a chisel by hand or machine, but how many of them are aware of the fact that great quantities of the files they use are not made with the chisel at all, but by a grooving process somewhat akin to knurling, and known as "etching"? The workmen shown in Fig. 9 are employed in this work. The file

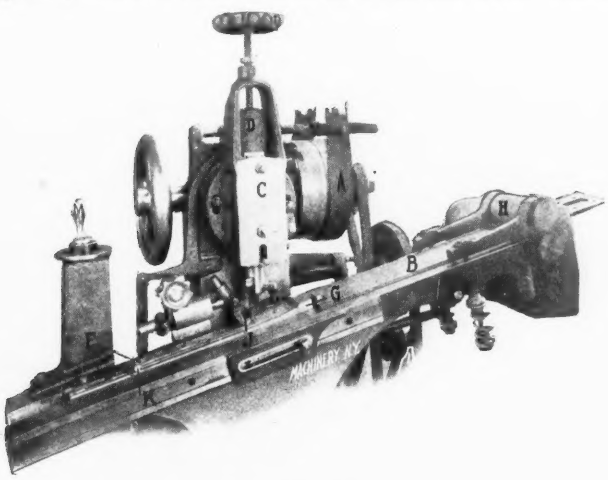


Fig. 8. File-cutting Machine.

being treated is laid in the holder as shown, where it is steadied and guided by the workman's left hand. With his right hand, by the handle which it grasps, he operates the etching tool attached to the swinging framework. This tool is a triangular bar with file teeth cut in each of its three edges. Any one of these edges may be presented to the work. The cutting of these teeth is an art in itself. They have to be made with uniform depth and regularity, since it is necessary for the teeth to "track" in the grooves previously cut in the work. The etching tool is simply swept back and forth across the work at the proper angle and with the proper degree of pressure, as determined by the foot of the operator

Fig. 9. Process of "Etching" Teeth on Files.

bearing down on the stirrup shown hanging from the handle. The teeth on the edge of the tool cut and trace out the grooves which are to form the teeth of the file. Simple as the process sounds, it requires a high degree of skill. No little training is necessary to give the steadiness of movement, evenness of pressure, and sureness of positioning needed. The process, as practiced here, is an improvement over that employed in Switzerland, where two operators are required, one to hold the blank and the other to guide the tool, using both hands for the purpose. In the case of round and half round surfaces, the tool is swept across the blank in a series of strokes from one end to the other on one portion of the surface. The blank is then rotated a trifle and the operation repeated, and so on until the whole surface is covered. So well must the etching tool be made, however, and so careful is the work, that the teeth are continuous throughout the whole surface.

A machine is being tried out in this shop for performing this operation. It is shown in Fig. 10. It duplicates the motions of the workman in the hand operation. The work is held at *A* and the etching tool at *B*. The tool is swept back and forth across the work on the angle desired for the tooth, the pressure being relieved on the back stroke. The blank is turned from time to time, if the surface is curved, so as to bring the whole area of the file under the influence of the etching tool. The process bids fair to be successful.

The shape of the file is the consideration which determines whether a blank shall be etched or cut with the chisel. A flat surface cannot be etched, nor is there any need for it. On round surfaces, however, particularly where it is necessary to preserve accurately the outline of the blank, etching is preferable to cutting. In a round file, the action of the chisel throws up the stock in such a way that the shape is polygonal, rather than round, when the file is completed. In etching, on the contrary, the process is that of cutting out the metal, leaving the original contour undisturbed. The workman cuts in with his etching tool only enough to bring the teeth to a sharp edge, without bringing this edge below the original surface. For this reason, in any curved shape where an accurate outline

Fig. 10. "Etching" Machine.

is desired, etching is the process used. Teeth coarser than No. 1 cannot readily be formed in this way, owing to the difficulty of applying enough pressure, and at the same time guiding the tool with precision.

The Hardening Department.

After the forming of the tooth, either by cutting or etching, the maker's name and the number are stamped on the file, and the extreme end, where the teeth are not perfectly formed, is sheared off. Then it goes to the hardening department. As before remarked, much mystery is made by some file making firms of the heat treating process. There is no mystery visible here, nothing but an application of common sense and long experience in the hardening of tool steel. The equipment of the room consists of two hardening furnaces, with lead baths, suitable brine tanks and brine cooling apparatus, and appliances for cleaning the files by a steam blast carrying a powdered earthen material. This is all shown in the general view of the hardening room, Fig. 11.

In hardening, the following procedure is adopted: A boy stands at the left of the furnace man, as shown in Fig. 12, the furnaces themselves appearing at the right of Fig. 11. The boy has at his left a pile of the files to be treated, and on the table back of him a supply of iron handles with sockets having holes pierced in them to match the tapered shanks of the files. At regular intervals, at such a rate as to always keep a certain number of files in the furnace, he inserts the shank of a file in the socket handle, which he lays on top of the furnace with the file hanging down into the pot of melted lead. The surface of the lead is covered with

coke dust, to prevent oxidation, and the temperature is kept constant at about 1600 degrees by a Bristol pyrometer.

As each piece of work becomes thoroughly heated, the operator removes it, plunges it into the brine tank and then into lime water, where it is cleaned, and then holds it for a moment under a steam jet. This latter heats it so that it dries immediately, thus obviating the danger of rusting. In small files especially, the transfer from the furnace to the brine tank has to be made very quickly, in order to prevent cooling before the water is reached. For this reason two tanks are provided. The small one, close to the furnace, is for small files, which cool too rapidly to permit a long journey through the

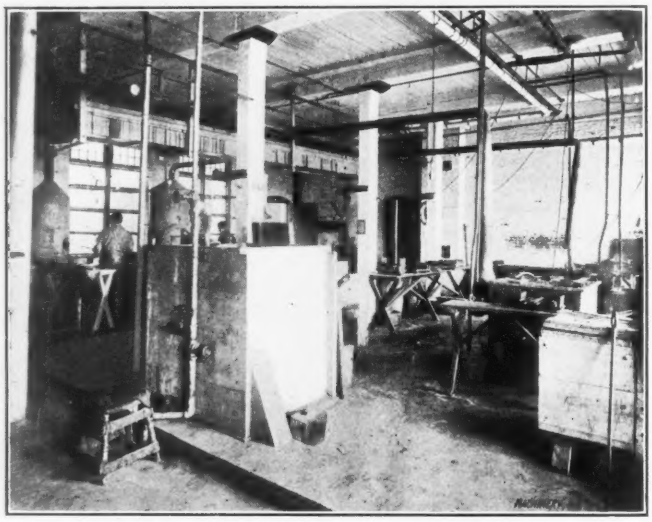


Fig. 11. General View of the Hardening Department.

cool air. The large one, a little further back, is used for larger work. The body of water in the large tank does not heat up so rapidly, and there is less danger of cooling with these files in carrying them the greater distance required.

Mr. Reichhelm is much pleased with the work of the Bristol pyrometer. It seems to do its work very accurately, is comparatively inexpensive in the first cost, and in renewal of the "elements," or that portion of the instrument which is subjected to the heat it is desired to measure. In his work, however, the pyrometer is used fully as much for keeping the temperature from fluctuating as it is for indicating absolute temperature. The condition of the work, as to color and hardness, is the prime consideration. When the bath is of such temperature as to give the required color and hardness, the pyrometer reading is noted, and the bath is tried from time to time to see that that temperature, whatever it may be, is kept constant.

The provision for furnishing a cool supply of brine is worth noting. The apparatus used is shown, diagrammatically, in Fig. 13. The underground reservoir contains a saturated solution of salt and water. This tank is of wood, on which, of course, the brine has no injurious effect. Located within it is a box of sheet lead, with an inwardly opening valve of the same material at the bottom, and an air supply pipe and an outlet pipe, also of lead, entering the top. The latter of these two pipes comes nearly to the bottom of the box. The operator at either of the two hardening furnaces, by pulling a cord, can open a three-way valve, which admits air under pressure at the top of the box. The box being full of brine, which has flowed in through the check-valve at the bottom, the air pressure closes this valve and forces the liquid through the outlet pipe into the cooling and supply tank above. This latter tank, seen in the foreground of Fig. 11, is high enough so that the brine flows from it by gravity to the bottom of the tanks at the furnaces. The cooled brine entering at the bottom of these tanks rises and displaces the warmer fluid, which runs through an over-flow at the top back to the reservoir again. In the cooling tank is a coil of pipe, through which water flows continuously from an artesian well sunk on the premises. This serves to keep the supply of brine cooled.

After the hardening there is a slight oxidation of the surface of the file, little more, however, than a stain; it could scarcely be called scale. To remove this the work is taken to the cleaning apparatus shown in the left background of Fig. 11. The sheet metal cases shown contain a quantity of water mixed with a fine clay. This clay is almost impalpable, with no perceptible grit that can be felt between the thumb and finger. A steam ejector draws the mingled water and clay from the bottom of the casing and directs it in a stream upward against the files, of which several at a time are grasped by the operator in a pair of long-jawed tongs. A few seconds' exposure to the blast, first on one side and then on the other, removes the stain from the cutting edges and leaves them bright and sharp. From here the files go to the packing department where they are inspected for hardness and accuracy of cutting, oiled, and wrapped in suitably labeled boxes ready for marketing.

Special Forms of Files.

What we have said of the methods of manufacture followed relates to files with more or less regular outlines, which readily admit of being formed and cut by machinery. Great numbers of special shapes have to be made, however, in which the use of machinery is impossible. In the case of the various forms of rifflers for instance, used by toolmakers and die-makers in working out otherwise inaccessible corners, the whole work of forging, stripping, cutting, etc., has to be done by hand, the surface being too irregular to admit of any other procedure. Other special forms of files are made here for various purposes. One interesting product is a form used in sharpening pins. It will be news to many mechanics, doubtless, to know that the points of pins are filed. The filing is done by square blocks of steel with single cut teeth formed in them, fastened to the sides of rapidly revolving disks. Large quantities of these are made here.

Swiss vs. American Files.

The Swiss file is the outgrowth of the Swiss watch industry, which is nearly or quite 200 years old. These watches have been and are now made quite largely by hand, so that the production of files of the very finest grade early became a vital necessity in that country. To this demand the high standard of the Swiss file may be traced. This excellence is due to the manual skill of the men who form the teeth, and the careful inspection which rejects all which are below the required standard of quality. As intimated, great skill is required to produce teeth of uniform depth and sharpness with the comparatively crude annealing methods used. The

Fig. 12. Heating Files in the Lead Bath.

workman must be continually varying the force of his blow as he reaches spots of greater or less hardness. In cases where the variation is too great, the file has to be rejected. In a similar way, with the hardening process used, the inspection weeds out a considerable percentage of failures. This care, and the expertness of the help, accounts for both the excellence and the highness of the price of the European product.

The conditions which make it possible to compete with these makers are: the scientific method of annealing which reproduces the same conditions day after day, and year after year, giving a uniform product requiring the discarding of very few pieces; the use of machinery in cutting the teeth, made possible by this uniformity of annealing and making

possible the cutting of good teeth at a not prohibitive cost; the ability to reproduce the same conditions in hardening day after day by careful attention to the uniformity of the steel, the tempering of the lead bath, and other qualities; and finally the exercise of the same old-fashioned care and conscience that show themselves so plainly in the product of the standard Swiss manufacturers.

In making these files in America, it was decided that no improvement would be attempted, for the present at least, in the shapes and sizes of the blanks and the fineness of the teeth. These designs have been the result of filling the gradually developing needs of some of the most skilled hand workmen in the world, so it is not the task of a day or a year to

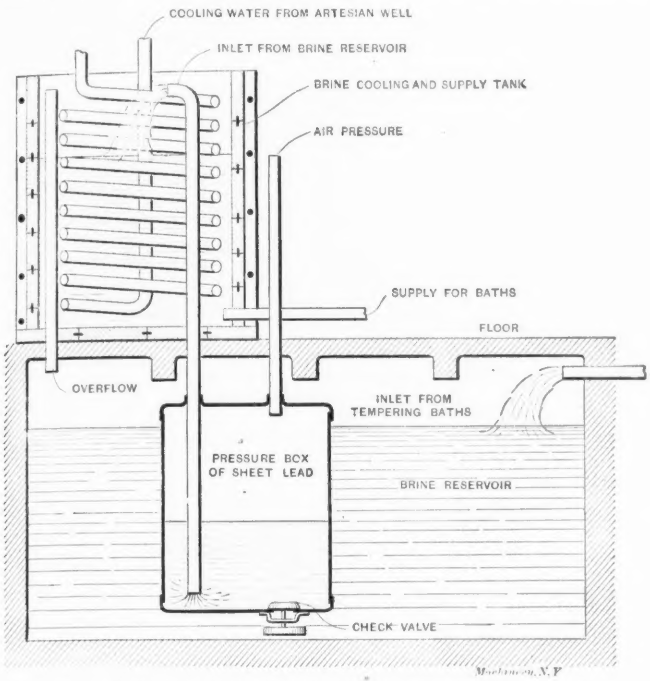


Fig. 13. Diagram showing Apparatus for Storing, Cooling and Transferring Brine.

devise anything better. For this reason, the product of this firm follows exactly in these particulars the product of the best Swiss makers.

This article has been given up largely to a description of machines and processes. Looking at the business in the way Mr. Reichhelm does, these machines and processes, important as they are, take a second place when compared with the necessity of having capable and efficient men to look out for them. It is fitting then that some of these men should be mentioned—the more, from the fact that the writer is indebted to them for the cheerfulness and intelligence with which they answered every question he saw fit to ask. Mr. Hermann Neff, superintendent, Mr. Ibach, the foreman of the forging and annealing rooms, Mr. Poncheron, the foreman of the etching department, and Mr. Kerr of the cutting department, may be mentioned in this connection, though, so far as the writer could judge, the name of every workman he met should also be included in the list. Mr. Joseph Broome, of New York, was the engineer responsible for the design of the buildings and the power plant.

* * *

A hammer, pliers, a cold-chisel or two, and a vise, in almost any old shack may, by courtesy, be called a shop, but the average owner of such an outfit seems to think that it will not be so regarded unless he scrawls somewhere on the inside or outside the legend "No admittance." So, wherever one goes, in town or country, the identity of the little tinker shop is revealed by this insulting and discouraging sign. Scarcely no other business would or could repel business in this foolish way, and why does the mechanic? His tools are not so enormously valuable, and of trade secrets he has none. Is the practice caused by an exaggerated idea of self-importance, or is it a custom inherited as part of the trade? Whatever may be its reason, it is a custom that is best honored in the breach. Common courtesy demands it, and a mechanic should not brand himself a boor by observing it.

THE BURGLAR AND THE SAFE-MAKER.

In the September, 1906, issue an editorial under the above caption appeared, dilating on the struggle that is constantly going on between the burglar and the safe-maker. In view of the statements then made, the following letter on safe-blowing from Consul Thomas H. Norton, Chemnitz, Germany, is of considerable interest to safe makers and users:

The confidence of German manufacturers of safes in the resistance of their wares against ordinary safe-blowing operations has been rudely shaken by the recent achievements of a single unaided robber in Dresden and other cities. The details of his last operation are as follows: A room was secured in a hotel, which was situated immediately above the office of a money changer. At night a hole was pierced in the ceiling of this office. By the use of a drill and saw a circular piece of the flooring was easily raised. Beneath lay a thick layer of cement. A small orifice was made in this and an umbrella shoved down into the space below. The umbrella was attached firmly from above, and when opened received without noise all the fragments of cement which were dislodged as the hole was enlarged so as to allow of the easy passage of a person. By means of a rope ladder the descent was readily made into the office below. Curtains were drawn, and with heavy blankets a tent was constructed around the safe, so thick that no ray of light could pass through. Next the robber brought down two cylinders of compressed oxygen and an acetylene generator charged with calcium carbide and water. With these he was able to produce a blowpipe flame of such intensity that steel fuses in it like lead in an ordinary gas jet. It required but a brief space of time to melt away so much of the door that all the contents of the safe were accessible. They were carried to the room above. At an early hour the robber left his lodgings and disappeared without trace.

The suggestions of the Consul for means to foil the efforts of the safe-cracking gentry are also of considerable interest:

It is evident from this experience that the builders of safes must provide for new contingencies in their constructions. The simple, light, acetylene generators, now in widespread use, and the equally simple oxygen generators, charged with water and sodium peroxide, or the heavier cylinders of compressed oxygen, place at the service of the intelligent crook the possibilities of opening the strongest safes in existence rapidly and noiselessly, provided the operator can be screened from observation.

Some large safes are so disposed that they are under frequent observation by watchmen looking through windows. Usually this observation is confined to the doors of bank vaults or the like, although in the case of the globular safes it practically extends to all exposed sides. In the greater majority of cases existing safes would offer next to no difficulty to a skillful cracksman if able to work without being seen. It is evident that owners will be forced henceforth to adopt such measures as will reduce to a minimum all possibilities of access to free-standing, movable safes, or the hidden sides of safes, embedded in cement or masonry.

Manufacturers of safes will, on the contrary, be impelled to fight the scientific burglar with his own weapons. In somewhat the same fashion by which time-locks prevent the opening of the lock of a safe during certain hours, it will be comparatively easy to introduce into safe construction chemico-mechanical devices which, during a limited time, would render it either fatal or physically impossible to remain in the vicinity of a safe or vault, were the walls or doors tampered with to such an extent as to allow access to the interior. By the use of a very simple form of apparatus containing potassium cyanide and sulphuric acid, a robber would expose himself to the deadly fumes of prussic acid.

Less dangerous, through possibilities of accident to those regularly using a safe, would be the employment of substances crippling a safe-blower or forcing him to an instantaneous retreat. The volatilization of a few drops of ethyl-dichlor-acetate would cause such profuse and persistent weeping that one in the neighborhood would be temporarily blinded if he persisted in remaining. The breaking of a tube of liquid ammonia would render immediate withdrawal imperative under peril of suffocation. Several similar compounds are at the service of constructors. Eventually the daring burglar, with sufficient scientific training, might venture to face the unknown dangers of a safe well provided with more or less effective neutralizing agents for the concealed possibilities of defense; but certainly for some time, at slight expense, effective protection can be devised against the attack of the scientific cracksman with his portable oxy-acetylene blowpipe.

Some of the measures suggested would be more dangerous to safe users than common prudence would permit, and as for all it is scarcely necessary for us to say that the ingenuity displayed by safe-breakers would probably enable them to readily overcome everyone of the obstacles suggested, for the Consul has practically admitted it, already.

REAMERS.—3.

ERIK OBERG.

Jobber's Reamer.

The jobber's reamer, Fig. 11, constitutes a class of reamers by itself. It is provided with a long fluted body and a taper shank, for use in machine; the corners at the point of the reamer body are slightly rounded, as shown at *a*. The radius for this rounded part should be about 1/32 inch for reamers smaller than ¾ inch in diameter, and 1/16 inch for larger

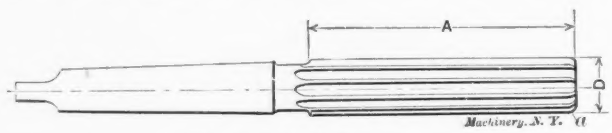


Fig. 11. Jobber's Reamer.

sizes. A neck is provided between the fluted portion and the shank, in order to permit of clearance for the grinding wheel when the shank and the fluted portions are ground. The length of this neck varies according to the size of the reamer. It is customary to make it about ½ inch long for a ¼-inch reamer, 1 inch for a 1-inch reamer, 2 inches for a 2-inch reamer, and 3 inches for a 3-inch reamer. The shank is nearly always made a Morse standard taper shank; the size of the shank used for different sizes of reamers is as follows:

Size of Reamer.	No. of Morse Taper.
From ¼ to ½ inch	1
From 17/32 to ⅞ inch	2
From 29/32 to 1¼ inch	3
From 1 9/32 to 1¾ inch	4
From 1 25/32 to 3 inches	5

Jobber's reamers are fluted with the same kind of cutters as hand reamers. The number of flutes is also the same as given for hand reamers in the August issue.

Dimensions of Jobber's Reamer.

As the length of the neck usually given to this class of reamers has already been stated, and as the number of the Morse taper shank determines the length of the shank part of the reamer, the only additional dimensions necessary are the length of the fluted portion and the diameter of the neck. The latter should be about 1/32 inch smaller in diameter than either the reamer itself or the largest diameter of the

TABLE X. DIMENSIONS FOR THE LENGTH OF FLUTED PORTION OF JOBBERS' REAMERS.

Diameter of Reamer.	Length of Flute.	Diameter of Reamer.	Length of Flute.	Diameter of Reamer.	Length of Flute.
D	A	D	A	D	A
¼	2	¾	4	1¾	6 11/16
5/16	2¼	⅞	4½	1⅞	6⅞
⅜	2½	1	5	2	7
7/16	2¾	1⅛	5½	2¼	7 5/16
½	3	1¼	6	2½	7⅝
9/16	3¼	1⅜	6¼	2¾	7 15/16
⅝	3½	1½	6⅜	3	8¼
11/16	3¾	1⅝	6½	..	...

Morse taper shank, depending upon which of these dimensions is the smaller; the only object is that the grinding wheel shall clear the neck when grinding the teeth as well as when grinding the shank. The length of the fluted portion may be determined from the formula:

$$A = 4\,D + 1 \text{ inch,}$$

for sizes up to and including 1¼ inch, and from the formula:

$$A = \frac{5\,D}{4} + 4\tfrac{1}{2} \text{ inches,}$$

for larger sizes. In these formulas, A = length of flute, and D diameter of reamer. Dimensions for the length of the flutes, approximately figured from these formulas, are given in Table X.

Shell Reamers.

In order to save the amount of stock which goes into the shank, shell reamers, having a hole through the center by means of which they are mounted on arbors, are quite largely used. As one arbor can be used for a number of reamers, the saving is quite considerable. An ordinary fluted shell reamer is shown in Fig. 12. The arbor on which it is used is shown in Fig. 13. The reamer has a keyway *A* which fits the key *B* on the arbor freely; the reamer, when at work, is rotated by means of this key and keyway. The hole through the reamer tapers, the taper being ⅛ inch per foot. Manufacturers of reamers have adopted certain standard sizes of arbors, and each arbor corresponds to a certain number of different sizes of reamers. Thus, several sizes of reamers are provided with the same size hole through them, and can be used with the same arbor. The arbor, as well as the hole in the reamer, must be ground after hardening, to insure that the reamer will run true. When hardening, if the

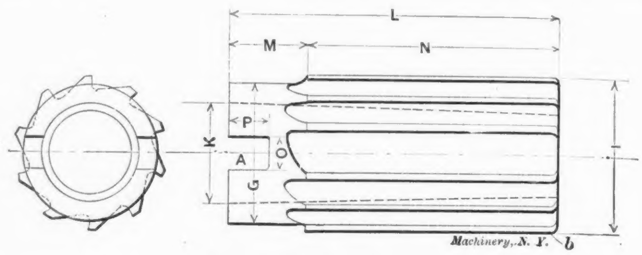


Fig. 12. Fluted Shell Reamer.

reamer is larger than 1¼ inch in diameter, its should be removed from the hardening bath, the same as large hand reamers, when it ceases "singing," and be plunged into a tank of oil, where it should remain until cool. When the tool is removed from the oil bath, or in the case of smaller reamers, from the water bath, it should be held over a fire and slowly revolved until at least partly relieved of the internal stresses, tending to crack the tool, which are due to the hardening process.

The outside of the reamer is provided with flutes and cutting edges for the greater part of the length of the reamer. A short distance at the end provided with the keyway is turned down below the diameter of the cutting edges. This is done in order to prevent any burr which may be set up by

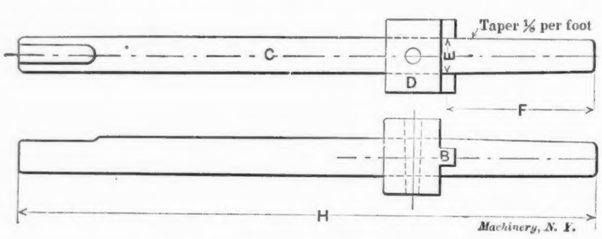


Fig. 13. Arbor for Shell Reamers.

the driving key on the arbor from interfering with the hole reamed, or spoiling the cutting edges of the reamer. Besides, this turned-down portion provides space for marking the reamer with its size, and gives a finished appearance to tool.

Fig. 14 shows a shell reamer fluted in the same manner as the rose chucking reamer. This reamer is termed a rose shell reamer. The cutting edges, fluting, and back taper are the same as described before under rose chucking reamers, September issue, but in all other particulars the tool is the same as an ordinary shell reamer.

Arbors for Shell Reamers.

The arbor used for driving shell reamers when at work consists of a stem, or arbor proper, *C*, Fig. 13, provided with a collar *D*, which is fastened to the arbor by means of a taper pin. On this collar a tongue *B* is milled on the end so as to provide for a key to fit the keyway in the reamer, as mentioned. Precaution must be taken in milling this tongue so that it is exactly in the center of the collar. The same care must, of course, be used in milling the keyway in the reamer, which must be exactly in the center. When grinding the outside of the reamer to size, it should be ground on an arbor similar to those on which it is to be used, and the edge at the front end slightly rounded as at *b*, Fig. 12.

Arbors, as well as driving collars, should preferably be made out of tool steel. The collar should be hardened. The arbors, as manufactured, are made in fourteen sizes, the diameters of each being measured at *E*, halfway between the end

of the key and the solid part of the body of the collar *L*. The arbor is provided with a flat milled on the shank for the set screws, by which it is clamped when held in position for work. In Table XI are given the most important dimensions for these arbors.

Fluting Shell Reamers.

The cutters used for fluting regular shell reamers are the same as for hand reamers. Rose shell reamers are fluted with the same kind of cutters as rose chucking reamers. The number of flutes in shell reamers must necessarily be greater in the smaller sizes than in corresponding sizes of solid reamers, because the flute cannot be cut so deep, owing to the thin walls of the shell. The number of flutes for regular shell reamers are as follows:

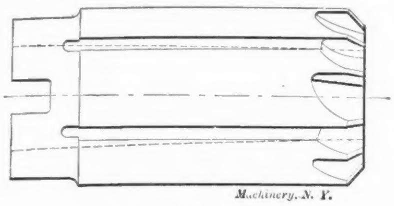


Fig. 14. Rose Shell Reamer,

Size of Reamer.	No. of Flutes.
From 1/4 to 3/8 inch	6
From 13/32 to 5/8 inch	8
From 21/32 to 1 1/2 inch	10
From 1 17/32 to 2 1/4 inches	12
From 2 9/32 to 2 3/4 inches	14
From 2 25/32 to 4 inches	16
From 4 1/32 to 5 inches	18

The number of cutting edges on the beveled end of rose shell reamers are equal to the number of flutes in the regularly fluted kind. The number of grooves on the cylindrical part of the rose reamer is, of course, half that of the number of cutting edges, there being one groove for every second cutting edge.

TABLE XI. DIMENSIONS OF SHELL REAMER ARBORS.

(See Fig. 13 for dimensions denoted by letters.)

Diameter at Size Line.	Length from Size Line to End of Arbor.	Total Length.	Diameter at Size Line.	Length from Size Line to End of Arbor.	Total Length.
E	F	H	E	F	H
1/8	1 1/2	6	1	3 1/2	12
3/16	1 3/4	7	1 1/4	3 3/4	13
1/4	2	8	1 1/2	4	14
3/8	2 1/4	9	1 3/4	4 1/2	15
1/2	2 1/2	9 1/2	2	5	16
5/8	2 3/4	10	2 1/4	5 1/2	17
3/4	3	11	2 1/2	6	18

TABLE XII. DIMENSIONS OF SHELL REAMERS.

(See Fig. 12 for dimensions denoted by letters.)

Diameter of Reamers.	Diameter of Hole, Large End.	Total Length.	Length of Turned-down Portion.	Length of Flutes.	Width of Keyway.	Depth of Keyway,
I	K	L	M	N	O	P
1/4 — 5/16	1/8	1 1/2	3/8	1 1/8	1/16	1/8
11/32 — 7/16	3/16	1 3/4	3/8	1 3/8	3/32	1/8
15/32 — 9/16	1/4	2	1/2	1 1/2	7/64	5/32
19/32 — 11/16	3/8	2 1/4	1/2	1 3/4	9/64	3/16
23/32 — 15/16	1/2	2 1/2	1/2	2	11/64	1/4
31/32 — 1 1/4	5/8	2 3/4	5/8	2 1/8	13/64	1/4
1 9/32 — 1 5/8	3/4	3	5/8	2 3/8	1/4	5/16
1 21/32 — 2	1	3 1/2	5/8	2 7/8	1/4	5/16
2 1/32 — 2 1/2	1 1/4	3 3/4	3/4	3	5/16	3/8
2 17/32 — 3	1 1/2	4	3/4	3 1/4	5/16	3/8
3 1/32 — 3 1/2	1 3/4	4 1/2	1	3 1/2	5/16	3/8
3 17/32 — 4	2	5	1	4	5/16	3/8
4 1/32 — 4 1/2	2 1/4	5 1/2	1	4 1/2	5/16	3/8
4 17/32 — 5	2 1/2	6	1	5	5/16	3/8

Dimensions of Shell Reamers.

The over all length of the shell reamer must evidently be the same as the length *F* on the arbor (Fig. 13), from the size line to the extreme end. As the same arbor is used for a number of different size reamers, these arrange themselves in certain groups with the same total length. The length of the fluted portion in each such group is, of course, also the same, as well as the dimensions for the keyway. The only dimension which varies in each group besides the size of the reamer itself is the diameter of the turned down part *G* (Fig. 12). This dimension should be as much less than the diameter of the reamer, as stated below:

Diameter of Reamer.	Amt. Diam. of Recess should be less than diam. of Reamer.
1/4 — 3/8 inch.	0.006 inch.
7/16 — 3/4 inch.	1/64 inch.
13/16 — 1 inch.	1/32 inch.
1 1/16 — 1 1/4 inch.	1/16 inch.
1 5/16 inch and upward.	1/8 inch.

In Table XII are given the dimensions for the various groups of shell reamers corresponding to the different arbors.

* * *

PATCHING DRAWINGS.

In the January, 1906, issue of MACHINERY was described the drafting-room practice of a large machine tool building firm in the matter of making extensive changes on drawings. In the drafting-room in question tracing cloth is not used, bond paper being employed instead. On this paper pencil drawings are made, which are afterward inked in and used to take blueprints from. Paper can be used of such quality as to be not much inferior to tracing cloth in the matter of rapidity and clearness in printing. The writer of that article referred to the matter of the ease of making changes as being one of the points of superiority of bond paper over tracing cloth. The method employed is to cut out with a sharp knife the portion affected, if the change is at all extensive. With the removed portion as a templet, a new patch is cut out from unused paper, about 1/16 inch larger in every dimension than the hole it is to cover. This is pasted in place on the back of the drawing by the margin thus left around it.

Since seeing the above, the writer's attention has been called to the practice of another large drafting-room engaged in machine tool design in which, also, bond paper drawings are largely used. Here, when drawings have to be patched, a sheet of clean paper is laid under the affected portion, which is removed by cutting with a sharp knife. The knife passes through both sheets of paper, thus providing a patch to fill the opening at the same time. To fasten this to the main body of the drawing, a sheet of transparent paper spread with clear mucilage is used, if the patch is small. If of considerable size, the joint is neatly covered with thin strips of gummed transparent paper about 1/8 inch wide.

The advantage of this method is the smoothness of surface produced. The patch is flush with the main body of the drawing paper and the drawing instruments pass over the joint between the old and new portions without difficulty. It would be especially useful in cases where alterations are made on thick drawing paper. When neatly done with a sharp knife, the joint in such cases is almost invisible. The writer has employed it on tracings, where it worked very well, although it has been found that ordinary library paste is not permanently effective in making the joint. A good clear mucilage should be used.

* * *

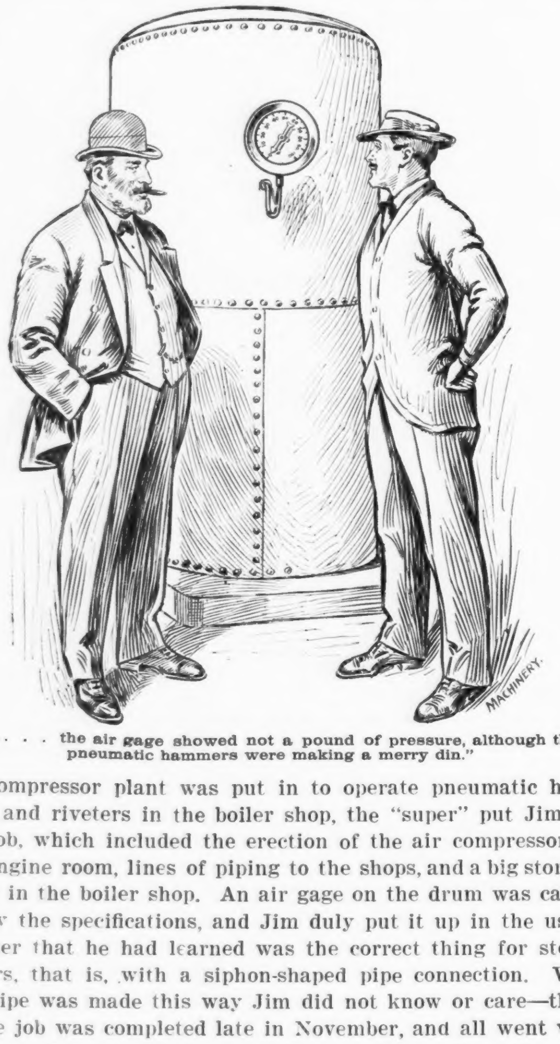
In our September issue we described a course of instruction for draftsmen at the American Locomotive Co., Schenectady, N. Y. The General Electric Co. at Schenectady also has an apprenticeship system for the training of draftsmen, conducted along similar lines. For admission, the apprentice is required to pass a stiff examination in arithmetic, which most of the candidates fail to pass. Those admitted first spend about three months in the blue-printing department, then six months in the tracing department, this latter period being considered sufficient for turning out an expert tracer. After that the student is kept for a year in the factory, being transferred as a rule from department to department every three months. After that the final two years are spent in the drafting room. During the whole time the student is required to study algebra, geometry, trigonometry, projections, strength of materials, etc., and to draw and trace fifty instruction sheets from sketches furnished to him. The pay of the apprentice during the four years' training ranges from $3.40 per week during the first six months to $7.50 a week during the last year.

PIPING AN AIR GAGE.

M. E. CANEK.

Jim Peters learned his trade at Clark Bros.' engine works, and continued to work there after his apprenticeship was served. He was considered a good man, capable of doing almost any job from boring a cylinder to setting up an engine, hanging a boiler or running a line of steam pipe. He was steady, sober and industrious, but had one fault that sometimes led him into blunders; and that was, he did not always find out the "reason why." He had learned almost everything he knew about the trade by experience, and had accepted many shop practices without fully knowing why they were followed. One of his blunders—the last—was piping an air gage, and what he learned from that experience was much more valuable than the actual facts, for after that day he made it a rule never to do anything without knowing *why* he did it.

Ben Clark, the junior member of the firm, was the superintendent and general foreman of the machine shop. When an



" . . . . the air gage showed not a pound of pressure, although the pneumatic hammers were making a merry din."

air compressor plant was put in to operate pneumatic hammers and riveters in the boiler shop, the "super" put Jim on the job, which included the erection of the air compressor in the engine room, lines of piping to the shops, and a big storage drum in the boiler shop. An air gage on the drum was called for by the specifications, and Jim duly put it up in the usual manner that he had learned was the correct thing for steam boilers, that is, with a siphon-shaped pipe connection. Why the pipe was made this way Jim did not know or care—then.

The job was completed late in November, and all went well for several weeks, until one frosty morning in December the foreman of the boiler shop called the super's attention to the fact that the air gage on the drum showed not a pound pressure although the pneumatic hammers were making a merry din. One glance at the pipe connection told the super what was the matter. Going into the machine shop he walked up to Jim and said:

"Did you ever stop to think?"

"W-w-what's the matter now?" said Jim, growing red in the face, for he "smelled a rat," as the boys say.

"Why do you connect a *steam* gage with a siphon pipe?"

"I-I-I don't know," confessed Jim.

"Just what I thought," said the super, "for if you did you wouldn't have been such a fool as to put one on an air gage, especially in a cold boiler shop. Have you worked all these years here without learning that the siphon loop is simply a trap for condensation to protect the works from the hot steam? Pretty thing, though, to put on an air drum to freeze up over night. Looks nice, doesn't it—and *so-o-o* useful—but you'd better straighten it."

The super said no more; the boys attended to that very well, and Jim did not hear the last of his air-gage siphon for many months.

Jim is nearly through with his correspondence course now, and he is growing to think that perhaps the air gage job was a good thing after all. A mental jolt sometimes works wonders on the right sort.

* * *

TINNING CAST IRON.

J. E. K.

The process of tinning cast iron is not understood by a great many persons who it seems would be familiar with the process, and for the benefit of these, I will briefly outline the method generally employed for this work. Of course, the castings must be absolutely clean and free from sand or oxide. Time spent in thoroughly cleaning the castings at the outset is time well spent, because many troubles which sometimes occur later in the process, causing loss of time and material, could be obviated if the castings had been thoroughly cleaned. The scale or oxide should be removed so the clean metal will be exposed to the tin. After passing through a "rattler" which removes a great deal of the scale, the parts are placed in a pickle of dilute muriatic acid until a clean surface is obtained. This pickle is warmed in some shops by means of a steam jet, and a quicker result is obtained. The castings can be examined occasionally while in the pickle, and any sand or black spots removed by means of a wire brush. The castings after coming from this pickle are washed in clean water. If for any reason it is desired to keep the cleaned castings for any length of time, they may be preserved from oxidation by being left under water. For a flux, the castings are dipped in a mixture composed of four parts of a saturated solution of sal-ammoniac and one part of muriatic acid.

The best block-tin should be used for tinning. Melt this in an iron pot, taking care that it is not burned or overheated in melting. After the tin is melted, it should be cleaned of all impurities. This can be done by taking a piece of green or wet wood secured to a pointed iron rod, and fastening it so that the wood will be kept at the bottom of the pot of melted metal for one or two hours, depending on the amount of impurity in the metal. The surface of the metal is skimmed occasionally by means of a perforated iron skimmer. To protect the surface of the metal from oxidation it can be covered with sal-ammoniac. There is nothing to be added to the tin. Tallow or palm oil may be used for covering the surface instead of sal-ammoniac.

The casting is taken up by means of suitable tongs, dipped in the flux, and then immersed in the melted tin, and held for a sufficient time to allow the surface to be tinned. The tin should not be so hot as to discolor when the casting is removed. If desired, the casting can be held for a time in another pot, which is kept partly filled with tallow or palm oil and kept at a temperature that will melt tin. The bath of grease will allow the casting to retain an even coating of tin, and allow any superfluous metal to drain off. The castings may be cleaned from the grease by rubbing with sawdust and then with bran.

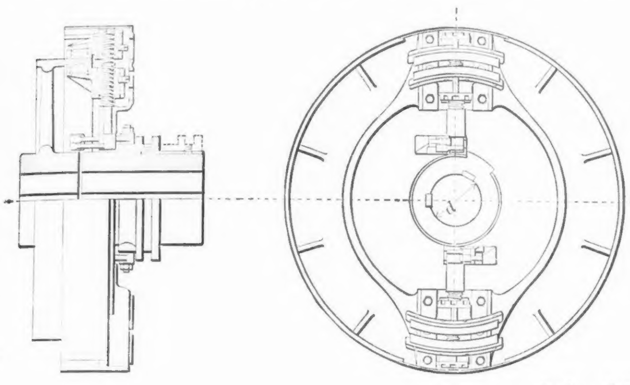
* * *

The Arthur Co. has a clock face on the exterior of its building on Front St., New York, the hands of which are driven by a "grandfather" type clock in the office. A novelty of the arrangement is a face with hands on the "back" of the clock facing the interior, the numbers being arranged in reverse to the usual clockwise order, of course. This very unusual feature never fails to attract the attention of visitors—and that is its principal object. The reversed clock face may be made to serve another useful purpose, according to an exchange. A barber in St. Louis has a clock so arranged for the benefit of his customers who when in the chairs can thus readily tell the time from the reflection in the mirrors. Ordinarily one so situated has to perform a mental somersault to tell the time from the reflection, but this innovation makes the reflection the same as the real thing.

ITEMS OF MECHANICAL INTEREST.

NEW FORM OF GRIP-JAW CLUTCH COUPLING.

A German firm, the Peniger Maschinenfabrik und Eisengiesserei A. G., Penig, Saxony, is manufacturing a new form of clutch coupling based on the old principle of jaws, actuated by a right- and left-hand screw, gripping the rim of a pulley. The cut herewith shows plainly the construction and action of this device. A sleeve, traveling back and forth on the hub of the pulley which is keyed to the shaft, and actuated by a shifting lever, not shown in the cut, turns by means of a lever

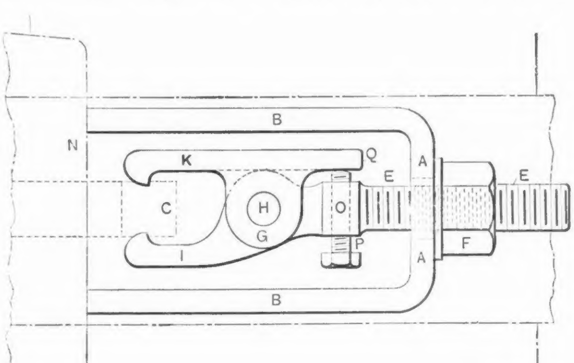


Grip-jaw Coupling.

and crank, the right- and left-hand threaded screw, thereby causing the jaws to grip the loose pulley and drive it. The jaws are made of wood, and fastened by wood-screws to cast iron brackets in the driving pulley. The dotted lines at the end of the hub of this pulley indicate the position of the operating sleeve when the jaws release the loose pulley, and the sectional view of the sleeve indicates its position when the jaws are brought in contact with, and drive, the loose pulley. The cut shows a pulley with only two pairs of jaws, but larger sizes are made with four pairs of jaws also, to provide for greater efficiency.

KEY-EXTRACTING DEVICE.

The accompanying cut, taken from the *Mechanical Engineer*, August 10, 1907, shows a device for extracting keys from their seats in pulleys, etc. It has been patented by Messrs. T. Barnes and J. E. Walpole, of Chester, England. The device consists essentially, as seen from the cut, of a bridge piece, a screw supported by the bridge piece, and a clamp adapted to grip the key. The bridge piece *A* has two legs *B*, the ends of which rest against the boss of the pulley or other object from which the key *C* is to be ex-



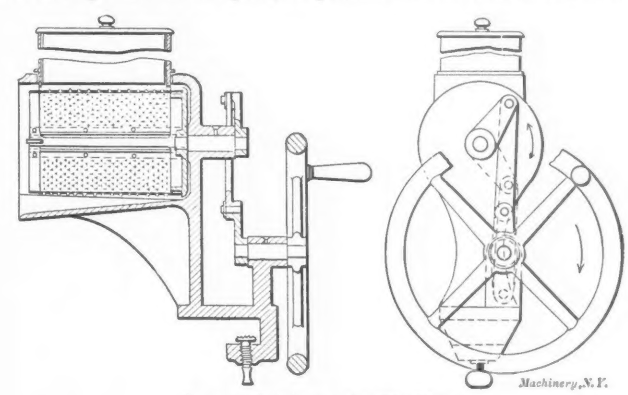
Key-extracting Device.

tracted. A screw *E*, provided with a fine pitch thread passes freely through a hole in the bridge piece *A*. On the outer end of the screw *E* is mounted a nut *F*. The inner end of the screw is provided with a boss *G*, and with an arm *I*, for gripping the key. Through a hole in the boss *G* is passed a pin *H*, which pin carries the arm *K*, forming the gripping jaw opposite the arm *I*. The extreme ends of the jaws are provided with inwardly projecting V-shaped edges which engage with grooves formed in the vertical sides of the key *C*. These grooves must be provided for in the key before it is originally driven into the keyway of the pulley. The screw *E* is also provided with a boss *O* through which passes a set screw *P*, bearing against the heel *Q* on the arm *K*, so that on turning the set screw the jaws are caused to grip the key. The device can lay very close to the shaft when it is required to extract a key from a boss located on the lineshaft. When the parts are engaged in the manner just stated, the nut *F* is turned on the screw *E* with a wrench, and the legs *B* are forced against the boss *N* of the pulley or other object from which it is wanted to extract the key. A further turning of the screw withdraws the key from the keyway. The device, during use, rests upon the shaft carrying the pulley.

A POTATO-RASPING MACHINE.

The following cut and description are taken verbatim from the English edition of a German periodical called "The Sun." This typographical luminary radiates information relating to German patents, with the hope of attracting American and English investors to them. We feel no hesitation in reproducing this matter, being given *carte blanche* for so doing by the following note on the title page of the paper: "For the press: The original essays published in the *Sun* may be used and copied, without mentioning the authority at will. Stereotypes to the reddition of the drawings are send with obligation for free sending back gratis and frank, if wanted."

Here follows the description: "To Mr. Gieler, Weida, has been granted a patent for a new potatoe-rasp in Germany and other countries, as it is shown in the drawing. The times where the potatoes in the kitchen had to be squashed with a wooden spoon ect. are past, at present we do that much better



German Potato-rasping Machine.

and quicker with a machine. Till now we have made known with several rasps, but we can say, without enlargement that Gielers' system belongs to the best ones. It is indeed emminent simple and comfortable too. It has the profit that the pap can be made refined and grossly. You only have to change the raspingroll. Except this the machine is to make in pieces very easily, to clean it in the most commode manner, what also is a great profit. You spend not too much time by cleaning it and it is absolutely necessary. Each lady of the house, who has been acquainted with Gielers rasping-machine can not be without it."

We can't help wondering if the translations into German of some of *our* trade literature, may not be almost as interesting as the sample given above.

* * *

In a paper presented before the annual convention of the National Electric Light Association by Mr. Paul Lüpke of Pittsburg, some reference was made to the question of selecting help and building up an organization, and the ideas put forth are well worth being repeated. "The right time," said Mr. Lüpke, "to look out for your head fireman is when you hire a coal passer; for your chief engineer when you hire an oiler; for your chief electrician when you hire a machine wiper. This plan avoids much shifting. Floating help is a most serious hindrance to economy and good service. Any bully can discharge a man, but it takes a sage to hire a better one in his place."

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1907.

PAID CIRCULATION FOR SEPT., 1907, 23,967 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

The yearly indexes of the engineering and shop editions of MACHINERY and RAILWAY MACHINERY are now ready, and copies may be obtained upon request.

* * *

VALUE OF SAFETY APPLIANCES.

The steam gage, the safety valve and the water gage of the steam boiler are essentially safety apparatus, but they are no longer looked upon as simply safety appliances, but as necessary features of any complete boiler installation. So it should be with many other features of mill and factory equipment. The tendency is to regard a feature which is designed merely to prevent injury to employes as something of a philanthropic nature, which is to be grudgingly applied, perhaps. A reason that the safety appliances of a boiler are regarded as necessary is because that the enormous damage done by boiler explosion is something to be feared, and most factory owners seek to safeguard their property in this and other respects as much as possible. In the same way they should seek to safeguard the safety of employes, for it is as much to common interest, directly and indirectly, that they be protected from injury, as it is that the plant itself should not suffer. Employers are slow to learn that in a well-established business their most valuable asset, oftentimes, is the employes rather than the plant. The fact that one is a tangible asset, and the other an intangible asset, does not alter the fact.

* * *

THE REACTION.

The present business situation is more than ordinarily perplexing. Some lines of trade report business good and orders ahead of last year. From many points, especially in the West, we hear that money is plentiful and not a speck visible on the business horizon. New York seems to be the only point where money is scarce, although we have managed to subscribe several times over for the last city loan.

The opinions of machinery manufacturers agree that a recession of business in our line is actually here; but they also agree that this recession will be a benefit instead of an injury, because it will allow them to get down to a normal basis, to handle their orders more promptly, and to reduce the cost of their product so that it can be marketed at prices more satisfactory to purchasers, especially those abroad, than has been possible for the past year or two. Very few people of good judgment expected that business would continue at the recent pace, and now that the pendulum has begun to swing backward, all prudent manufacturers will put their business in such shape that, when the inevitable upward swing starts, they will be prepared to take advantage of it.

The immense amount of wealth accumulated in this country during the past ten years or more has made impossible a recurrence of the panics and hard times we formerly had. The changing conditions imply a moderate reduction in total output and a healthy readjustment of values, which will enable us to continue on a firm basis.

* * *

THE EXTRA DATA AND SHOP OPERATION SHEETS.

The popularity of the data sheets and of our shop operation sheets, and the large amount of matter contributed for use in this form, have made it necessary for us to issue extra sheets of both, which, on account of the additional cost, cannot be included in the paper, but which MACHINERY readers can obtain by merely extending their subscriptions. The data sheet in this issue of MACHINERY (engineering edition) is No. 80, although the September data sheet was numbered 73, the intervening numbers, 74 to 79, representing six 4-page data sheets, comprising twenty-four 6 x 9-inch pages, published during October.

The twenty-four extra shop operation sheets are now ready, and are numbered 19 to 42, following numbers 16, 17 and 18 in this number of MACHINERY. The shop operation sheets in the November number will begin with 43, the intervening numbers representing, as we explained above, extra sheets which will be furnished without charge to MACHINERY subscribers who continue their subscriptions.

MACHINERY's regular data sheets, as our readers have noticed, are now bound in the paper instead of being folded in as supplements. This change enabled us to comply with certain restrictions of the post-office governing supplements issued with periodicals, and allows us to furnish our readers with a great amount of valuable data which we were not permitted to mail in the loose supplement form.

* * *

MISPLACED ECONOMY.

The tendency of some people to begrudge every expense for shop equipment is so old and well-known a condition that it is needless to repeat it, excepting as a matter of fact. This tendency, however, has had an unfavorable influence on the estimation of the actual value of the milling machine. The successful operation of this machine depends to a great extent, or one might well say chiefly, upon the kind of tools with which it is used. In the successful use of the milling machine on anything excepting the very plainest class of work, the cutters and fixtures used play a role fully as important as that of the machine itself. The firms who begrudge every penny that is spent upon accessories, and simply install a milling machine in the shop provided with plain cutters and arbors, and one or two ordinary vises, and then expect the operator to take any kind of a job and prove the excellence of the machine as compared with a planer or shaper, are greatly mistaken as to the best way of getting the full efficiency out of a milling machine. In such a case one might even say that a great deal of the money paid out for the machine itself is practically wasted. Still, the idea that when a high-grade milling machine is installed in the shop, all that is necessary has been done, is a greatly prevalent view, and one which is altogether too common where men, not directly acquainted with the mechanical operations of a shop, and all the little details combined with it, consider themselves able, with little or no advice from the actual operators, to equip the shop in the manner tending to give to each machine its greatest efficiency. In such cases a good machine, which would prove an excellent tool if equipped in the best way, might prove less efficient than older methods. The result is a greatly reduced output and the machine, and sometimes the operator as well, are blamed, when really the cause of the trouble is to be found in the inexperience, and perhaps stinginess, of the very persons who would be most benefited by the additional outlay necessary for proper cutters and fixtures.

AN APPALLING BRIDGE FAILURE.

Never has the engineering world been so inexpressibly shocked as by the awful collapse of the partially built Quebec cantilever bridge spanning the St. Lawrence River. On August 29 the completed south cantilever span, with a section of the suspended span went crashing down into a mass of inextricably tangled wreckage. Of the 85 men at work 74 lost their lives and all the remaining 11 were badly hurt. The loss of life and property is enormous, but still greater is the loss of engineering reputation and prestige. The world regards with amazement and horror an engineering work costing millions, on which years of presumably the best engineering talent of America had been employed with a result so pitifully futile. One-half of the greatest bridge of its type ever designed, having a clear span of 1,800 feet and requiring 38,500 tons of structural steel in its entirety has collapsed of its own weight.

The disaster loses little of its stunning force or reproach to the engineering profession because it apparently suggests that an unknown source of weakness exists in very large and long compression members. That such a condition may exist is what the *Engineering News* would have us believe from reading its seven-page report and masterly editorial (issue of September 5) which are technical efforts seldom surpassed. But it is hard to understand how the deductions of engineers in regard to members carrying compression loads could have been so signally at fault, notwithstanding the absence of experimental data on very large columns. Such an admission would suggest that our entire theory of the strength of materials may need revision. Rather would we accept the suggestion that chord *A9L* had been structurally or molecularly disorganized by the several accidents befalling it before erection, or that a serious mistake was made in its design, especially in the matter of side-staying. The fact that it was the apparent initial source of failure will go a long way with the layman, notwithstanding any engineering testimony to the contrary implying that its various mishaps were of no important ultimate effect.

* * *

THE STATUS OF THE DRAFTSMAN.

From several points of view, the draftsman occupies a more peculiar position in the modern shop than many of the other workers who make up the organization. The draftsman is considered by many a manager as a kind of necessary evil, a dead expense, which he cannot avoid. For behold! the drafting-room is a non-productive department. At the same time the drafting room of any well-organized shop is recognized as the heart of the industrial end of the business, in which the planning and systematizing forces, at least to a large degree, are located. The draftsman himself occupies a very different ground in different shops, according to whether the former or the latter view expressed is the prevailing one in a particular organization. Of course, there are draftsmen and draftsmen. There are those that are valued at $10 a week or less, and those that are valued at $40; and this fact, too, tends to place the knight of the T-square in a peculiar position. There are no very well defined limits to his trade. He is more or less what one might call a free lance. In many a case he is not even a distinct part of the regular organization. He is called in when a new design is to be turned out in the drafting-room, and when that is done he is "laid off." At least, this is the case in the majority of smaller shops, specializing on one or a few kinds of standard machines. The last contention may, perhaps, not apply to the leading designer, but it most certainly applies to the ordinary draftsman.

The conditions outlined are by no means very satisfactory, but it is difficult to propose a remedy. It has been suggested that men in the shop, having training in drafting, be temporarily taken into the drafting-room to help out when business there is pressing, rather than to hire draftsmen for short terms. But this course would be subject to many objections. In the first place, nobody does the draftsman's work as well as a trained draftsman, constantly working at his trade. In the second place, it is not at all sure that the very men with drafting experience, wanted from the shop, can be spared there at a particular time, and last, but not least, the man, who at first would be only temporarily taken from the shop for drafting-room work, would soon find a certain attraction in his new occupation, and, in nine cases out of ten, he would not return to the shop again, but continue on what, at first sight, seems to him the rosy road of the draftsman. To the ordinary shop worker, the drafting-room has at first many attractions. The work is cleaner, the duties, at first, less exacting, the surroundings more pleasing, and the hours generally shorter. In the long run, however, it is evident that the draftsman, having passed through the stages of assistant to that of independent designer, finds the limitations greater in this department than in the productive departments in the shop. That is why we find so few old draftsmen. We do not realize where they go to; all we know is that they disappear from the drafting-board as they grow older.

The cause for this is perhaps the kernel of the matter of the comparatively unsatisfactory status of the draftsman. After long years of close attention to business, he has become an expert designer, and his work requires all the mental qualities present only after years of training and experience. His general intelligence, measured in units of logic, is greater than that of most of his cooperators in the industrial organization. He is the ingenious planner and schemer of profit-making devices, and even though, in certain cases, some ideas are furnished him by "the man higher up," these ideas, as a rule, are furnished in such a crude form that the draftsman is but little helped in his work. When the device is completed, however, the honor of the successful working does, curiously enough, not fall upon the one to whom the most of the credit is due. When we also consider that the compensation paid to the most skillful of machine designers is often, not to say nearly always, less than that of department foremen, many of whom in intelligence and general ability are far inferior to a trained designer, then it is easily seen why we find the draftsmen leaving the chosen trade, as soon as they have reached middle age, to seek more congenial occupations. This, however, is a distinct loss to the industries as such. The best and ablest men, the most experienced designers, are lost to the craft at the very time when their services would become most valuable. If the draftsman were considered a more integral part of a shop organization, if his merits were recognized, rather than usurped, by his superiors, and if his compensation stood in a more equitable proportion to his achievements, he would be less tempted to leave that place in the industrial organization where he serves the best, for other occupations, far better compensated, but requiring no more intelligence, judgment or ability.

* * *

An item of mechanical interest appeared in the June issue illustrating the power of a small force to displace plastic substances such as asphalt, cobbler's wax, etc. Another illustration that is of considerable scientific interest is the alleged cause for the winding grain of certain trees. It is asserted that the cause for the twisting grain of trees having wide-spreading branches is the rotation of the earth on its axis. It is well known that the rotation of the earth causes whirlwinds or cyclones in the air, and vortices in water. In the northern hemisphere these always move in a counter-clockwise direction, and it is claimed that the trees are twisted in the same direction by the same force. The cause of whirling motion in air and water is the slight difference in the earth's motion between any two points on a line of longitude. A railroad train, for example, running on a straight track toward the north, in the northern hemisphere, crowds over to the right-hand or eastern rail, and when running to the south it again crowds to the right-hand rail, but which is now the western rail. The reason is that the inertia of the train causes it to move ahead of the earth's motion, or fall behind it, depending upon whether the travel is north or south, on account of the velocity of the earth's surface decreasing as we approach the poles, or *vice versa*. The influence of the counter-clockwise air currents and the inertia of the sap, rising from the roots and flowing from the trunk out towards the limbs, is believed sufficient, though slight, to give tree trunks, plants, etc., a twist counter to the motion of the hands of a clock.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

On the German state railways accumulator cars have been running since last February on three railway lines. The new cars run four to six times a day over a distance of about eight miles. The cars are three-axle cars built especially for this purpose. The batteries consist of 180 cells of 200 ampere-hours capacity. A car battery weighs about 10 tons and yields 685 kilowatt-hours. The car complete weighs 38 tons.

In our issue of May, 1907, we gave a general description of the system of transmission of photographs which has been developed and brought to comparatively high perfection in Germany. It is now reported that successful experiments have been carried out over a line of 320 miles from Munich to Berlin. The photographs were clearly transmitted over a commercial wire loaned to the experimenters by the government.

Speed trials were made during the month of August with the first-class battleship *Connecticut*, the first battleship of this class built at a government shipyard. In a series of fourteen runs over a measured mile, she averaged, according to *Engineering News*, for the best five runs, a speed of 18.73 knots. The *Louisiana*, her sister ship, built by the Newport News Shipbuilding Company, attained only 18.59 knots as the average speed of her best five runs.

Liquid fuel for locomotives is becoming more and more common in the southern portion of the United States as well as in Mexico. It is reported by the *Torreon Star* that the Mexican Central Railway is using 4,000 barrels of fuel oil daily, and is steadily increasing the number of oil-burning engines in its service. All new engines purchased are equipped for the burning of oil, and old engines are constantly being remodeled.

As a result of the Postal Union Congress held at Rome in 1906, when international postage stamps were authorized, France issued an international postage stamp on October 1, and it is expected that a British stamp will also be issued. The stamp can be sent to most of the countries in the Union to prepay a reply to a letter, and also in payment of small accounts (up to 20 cents). Orders for four million stamps were placed, and if the experiment is a success the issue will be continued.

In a recent issue of the *Annales des Ponts et Chaussées*, Mr. M. H. Le Chatelier contributes an article regarding the action of sea water on cement and concrete, in which he states that all hydraulic binding agents without exception may be decomposed by sea water, although the rate of this action varies within wide limits. The most essential condition to render cements immune from decomposition in the sea is to reduce as much as possible the volume of water employed in gaging the cements.

The navigable dimensions of the Suez Canal have been practically doubled during the last twenty years. Taking the canal as a whole, its width at the water level in the northern half is from 300 to 360 feet, and in the southern half from 240 to 300 feet. In 1902 the maximum draft was raised from 25 feet 7 inches to 26 feet 3 inches, and in 1906, to 27 feet. The mean duration of transit is about 18 hours for all vessels, but the general effective rate for mail steamers is 15 hours. The length of the canal is 100 miles, and the ordinary rate of speed thus is 6 2/3 miles per hour.

A miniature head telephone has been developed in Sweden, according to a consular report. The receiver is said to measure ½ inch by ⅝ inch, and over the diaphragm may be screwed a cover continued into an ear tip. The connection to the receiver may be a fine flexible cord carried like an eye-glass cord. No helmet or other attaching device is required to hold the receiver in place. The instrument is thought to be valuable both to telephone operators and to individuals with defective hearing, the latter also carrying a transmitter, etc., on the person. The device was invented by the chief of the government telephone department.

The immense 41-story tower of the Singer Building on Broadway, New York, is rapidly going upward, and by the time this item is printed the entire framework will be completed. When the tower is completed, the flag-staff will be 652 feet above the ground. The unique appearance and great height of the structure will make it one of the most noticeable buildings in New York. On account of the great wind pressure that the structure will be required to withstand, the tower is built in a manner somewhat analogous to a bridge on end, so far as the bracing is concerned. It was designed to withstand a maximum wind pressure of not less than 30 pounds per square foot.

A correspondent to the *Times Engineering Supplement* describes the results of the trials of the Field-Morris system for increasing the thermo-dynamic efficiency of the steam engine. He states that by this system a saving of 24 per cent in fuel has been effected. The system consists of adding to the steam a certain proportion of air under pressure, this mixture then being superheated before being allowed to pass into the steam cylinders. The theory, upon which the saving claimed for this invention is based, is not manifest, but it is stated on good authority that the saving in several tests has been considerable, after due allowance has been made for power expended in compressing the air.

The new steel plant of the United States Steel Corporation at Gary, Ind., will be developed immediately on even a greater scale than was originally contemplated. It was originally intended to appropriate $75,000,000 for the construction of the steel plant and the adjoining new industrial town, but it has been decided that an additional $45,000,000 shall be set aside to be used in widening the scope and extent of the steel plant itself. When it is considered that in the neighborhood of $120,000,000 is to be expended in the establishment of what might be called one single industrial plant, the magnitude of the new steel works can hardly be compared with anything else of that kind that has so far been contemplated in this or any other country.

A subterranean canal, 4.3 miles in length, is, according to news dispatches from Paris, projected to connect the valley of the Rhone with the port of Marseilles. This tunnel will be, in point of quantity of material excavated, the largest in the world. It is estimated that 2,840,000 cubic yards will be excavated, against about 1,375,000 cubic yards for the Simplon tunnel. The latter is 13.8 miles long, but only 24 feet wide and 18 feet high; while the canal tunnel would be, with the towpaths on either side, 66 feet wide and 42 feet high. The canal would permit two barges to pass at any point. The cost of the tunnel, rendered necessary because the hills between the Rhone and Marseilles are too high for lock operation, is estimated at $6,900,000. The total cost of the canal will be $15,200,000.

A remarkable performance of a steam locomotive on a run between Munich and Augsburg is reported from Germany. The engine drew a load of 165 tons (150 metric tons) and developed 2,000 horse-power, maintaining for a considerable time a maximum speed of 96.5 miles per hour (154.5 kilometers). The whole journey of 40 miles was performed at an average speed of 81 miles per hour. It is claimed that the speed of 96.5 miles per hour is the highest speed that has ever been attained on a European railway with a regular train. The locomotive weighs 90 tons, and with its tender 147 tons. The Bavarian minister of transportation made the trip on the engine during the trials. The locomotive is of the 2—6—0 type, four-cylinder compound. The general

dimensions of the locomotive are: Diameter, high-pressure cylinder, 16 inches; low-pressure cylinder, 24 inches; stroke, 25 inches; diameter, driving wheels, 7 feet 2½ inches; diameter, truck wheels, 3 feet 3½ inches; total heating surface, 2,702 square feet; steam pressure, 210 pounds.

The vibration of the after-part of high-speed ocean liners driven by reciprocating engines is a serious trouble that has not been successfully overcome by any system of engine balancing. One of the swiftest of the ocean greyhounds, the Deutschland, has been most troublesome in this respect, although the engines are balanced by the Schlick system. The defect was recently largely overcome in an interesting manner. The pitch of the blades of the port propeller was reduced slightly, the effect being that the port engine runs eight revolutions faster than the starboard propeller in order to give the same effective thrust and speed of propulsion. This throwing of the engines out of step minimized the vibration of both the engines and the propellers. It long has been known by marine engineers that throwing the engines of twin-screw ships out of step tends to reduce vibration, but the trouble of doing this with propellers of the same pitch is the difficulty of steering, there being a tendency of the vessel to run in a circle, owing to the difference in thrust of the two propellers.

A peculiar action affecting the status of apprentices in Pennsylvania has been started by Thomas Carlin Sons Co., of Allegheny, Pa. The company has sued the fathers of six apprentices for $2,500 damages each under a law passed in 1713 which is known as the "White Slave Act." The boys were apprenticed to the firm for a term of 10,800 hours, divided into eight periods of 1,350 hours each, the pay being graded from 7½ cents per hour up to 16 cents per hour. Under the agreement the boys had the privilege of breaking the contract during the first period only, and after that they were bound to continue until the end of the term. The boys quit at the time of a machinists' strike, and refused to complete their contract; hence the action of the company to establish the rights of employers in apprentice indentures. If the suits fail, a precedent will be established that will make such contracts valueless in Pennsylvania, and will probably affect their standing in other states also. The defense will be that the contracts were burdensome, and that it would be an injustice to the minors to hold them to fulfill an indenture made by their parents.

The accompanying table, taken from *Zeitschrift des Vereines deutscher Ingenieuren*, gives some interesting figures regarding the estimated life of electric power and light installations. While being primarily of interest to electricians, this table has much of value for any one having to deal with depreciation of machinery and plant of this or similar character. The figures are collected from six different sources, from two English and two German authorities, and from the practice of English municipalities. On some points they will be found to vary widely, but, in general, all the various sources seem to agree fairly well.

Length of Life in Years of	Robert Hammond.	J. F. C. Snell.	Local Government Board.	London County Council.	German Sources.	
Buildings	60	60	30	50	66	100–150
Boilers	20	20	15	20	15	10–15
Steam Engines	20–25	25	15–25	20	20	20–25
Steam Turbines	..	..	..	..	20	..
Gas Engines	..	..	..	..	17	..
Water Turbines	..	..	..	..	22	20–30
Dynamos	25	25	20	20	20–22	18–30
Accumulators	15	10	5–7	20	10	5–10
Transformers	15	20	15	20	..	30
Switches	20	20–25	15	20	15	15
Conductors	25–30	15–60	12–15	12–30	25	10–30
Meters	10	15	5	10	..	..
Arch-lamps	10	15	7–10	..	..	...

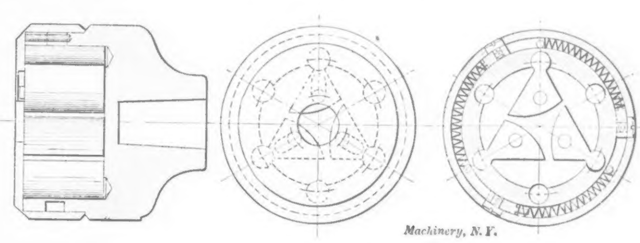
WIRELESS TELEGRAPHY ADVANCE.

The Poulsen selective system of wireless telegraphy, to which we referred in our engineering review in the February and March issues of MACHINERY, seems to be making rapid strides, and in one instance even to have established a record. The Poulsen system has been installed on board the *Hellig Olaf*, a liner belonging to the United Shipping Corporation of Copenhagen, and recently when that vessel was more than 2,000 miles distant in mid-ocean, a message of 21 words was despatched by her transmitter and successfully received at the Steglitz wireless telegraph station near Berlin, Germany. This is claimed to be the greatest distance a wireless message has ever been sent from ship to shore. In its career it passed over the ocean, across Great Britain, the North Sea, and again over the Continent to Berlin. This is the first time the Poulsen system has been worked on board ship. The American De Forest Company has, it is stated, covered 1,500 miles—from the West Indies to New York—and the Marconi system is continually doing long-distance work. But such messages have been from station to station or from shore to ship, not, as in the present case, from ship to shore, which is considered to be a much more remarkable feat.

GRIP CHUCK FOR STRAIGHT SHANK DRILLS.

Engineering, May 10, 1907.

A drill chuck working on the well-known eccentric clamping principle has recently been placed on the market by Ludwig Loewe & Co., Ltd., Farrington Road, London, E. C. The principle of this chuck is plainly shown in the accompanying cut. It is intended for instantaneous and automatic gripping of drills with straight shanks. The chuck takes drills from ⅛ inch to ½ inch in diameter. No key is employed to tighten or loosen the jaws, and there are no internal gears or screws in its construction. The milled cap covering the jaws has three radial slots in its inner face, which engage with pins on the respective jaws. The jaws terminate in cylindrical portions, about which they rock when the cap is rotated. Inside the cap are springs, which, acting



Grip Chuck for Straight Shank Drills.

between stops on the body of the chuck and other stops fixed to the cap, tend to cause the rotation of the latter, and so to close the jaws. The latter are serrated on their working faces, and these faces are so curved that the torque of drilling will clamp the drill and increase the tightness with which it is held. It is claimed that the grip is so efficient that high-speed drills may be driven with their full cutting efficiency, and in actual tests ½-inch drills of high-speed steel have failed under the work before the shanks have slipped in the chuck.

THE COST OF POWER PRODUCTION.

Western Electrician, June 8, 1907.

Prof. Charles E. Lucke, of Columbia University, having made a study of the subject of the comparative cost of various methods of producing power, with special reference to electric power stations, has collected some figures which he presented in a paper read before the American Electrochemical Society. He compared water-power development, oil engines, gas engines and producers, and steam engines, assuming a 24-hour continuous load in each case. In the case of the oil engines, 250-horse-power units coupled to 160-kilowatt generators were taken for example, and the station was supposed to contain six such units. As typical of steam engines, a plant of six 5,000-kilowatt units was selected, while for gas engines a station containing six 1,000-horse-power units

driving 600-kilowatt generators was chosen. Steam turbines were not considered in the steam plant, the author saying that the net result would not be very different from that of the reciprocating engines. Under these assumed conditions the comparison of power cost was figured as follows:

Water-power—First cost per kilowatt rating, $75 to $200; total power cost per kilowatt-year, $8.50 to $25.

Oil Engines—First cost, similarly, $217; cost of power per kilowatt-year, $78.64.

Gas Engines and Producers—First cost, $270; annual cost of power per kilowatt-year, $65.54.

Steam Engines—First cost, $110 to $150; power cost per kilowatt-year, $85.50 to $97.50.

The hydro-electric plant shows up very favorably, although it is to be noted that the cost of transmission is not included. The author thinks it likely that gas power will be cheaper than steam when the load factor is high, and that the difference will be greater as the cost of coal is greater. The figures given, of course, are only correct in a general way, "for," says the author of the paper, "the determination of power costs is not only a question of geographical location, a question of the generating system, a question of the size of the apparatus, a question of the perfection of its design, a question of the load location, but it is also a question of accounting, and the engineer engaged upon a question of this sort must not only be an engineer, but something of a financier and an accountant."

CENTRIFUGAL PUMPS FOR DEEP WELL PUMPING.

Abstract of Paper read by Mr. C. B. Burdick before the Western Society of Engineers, June 5, 1907.

This paper contains some interesting information relating to a new development of the centrifugal pump—namely, its use for lifting water from deep, driven wells. The first one built in this country was made by Mr. John W. Alvord as an experiment for a client, in 1902. The pump was so designed that various forms of impellers could be tried. This pump, fitted with the best impeller, showed an efficiency of 50 per cent when operating at 1,640 revolutions per minute, and discharging 835 gallons per minute against a head of 38 feet. The experimental pump had one impeller only and was designed to be used in a 12-inch hole. One of the most satisfactory features of this design was the means taken for handling the down thrust. Not only is there the weight of the long shaft and the wheel to be considered, but the reaction as well, due to the lifting of the column of water against the static and frictional head. The balancing was effected by means of a chamber in which pressure was maintained by leakage from the discharge side of the pump. When the pressure became great enough to lift the impeller and its attached shafts from the thrust bearing, by which it was hung at the top, discharge ports were opened by this movement which relieved the pressure so as to allow the parts to settle again. In the tests it was found that as soon as the pump came up to speed, the shaft was lifted about 1/16 inch and rode entirely clear of the balls in the thrust bearing provided at the top of the shaft. In this design both the impellers and the balancing chambers can be compounded for high lifts.

The water works at La Grange, Ill., are supplied with centrifugal pumps of this kind built by Mr. Byron Jackson, of San Francisco, Cal. His company is believed to be the first to place this type of machine on the market. The preliminary investigations seem to indicate that the pump efficiency is about 50 per cent, and the efficiency of the motor by which it is driven about 85 per cent. The motor is, of course, a vertical one, being a 25-horse-power Westinghouse three-phase induction type running at 112 revolutions per minute. It is connected to the shaft by a flexible leather link coupling.

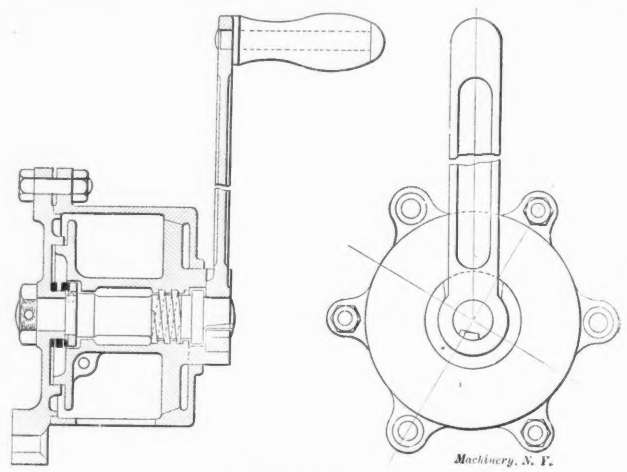
The obvious advantage of a pumping equipment of this kind is in its simplicity and compactness. It also has the advantage over the reciprocating pump of moving the column of water at a constant speed, not requiring it to be started and stopped at each end of the stroke.

SELF-SUSTAINING WINCH.

Page's Weekly, June 28, 1907.

The accompanying cut shows an ingenious, but simple, form of winch, originated in Great Britain. The chief features of the winch are that it is direct-driven, and that the drum is forced against and locked to the casing by the tension on the wire rope. In consequence of the latter feature, the greater the weight suspended, the more secure the hold will be.

The winch is provided with a common casing. This casing has at its central part a bearing, which supports one end of the shaft. The outer portion of the shaft is provided with a screw which engages with a corresponding screw thread in the drum. The periphery of the outer flange of the drum is coned and normally engages with a coned surface on the inner side of the outer part of the casing. The outer portion of the drum has a central boss which is supported in the casing and slightly projects beyond it. The end of the boss is recessed at its center to receive a crank handle. The hole



Self-sustaining Winch.

of the crank handle has an inwardly projecting lug, which engages with a slot cut in the end of the threaded shaft. This slot is made wider than the lug to allow the crank handle, during winding, to first move freely on the shaft, while the drum is being unlocked from the casing before the two move together. A portion of the metal around the recess in the center of the boss is removed so that the crank handle can drive the drum in one or the other direction, the gap so formed being of such width as to allow, during unwinding, an initial movement of the shaft with respect to the drum. A spring is placed between the inner end of the shaft and the casing to create a slight retarding movement on the spindle.

To use the winch the handle is placed on the outer end of the threaded shaft, the lug or key in the handle passing into the slot of the threaded shaft, and the web of the handle into the gap in the outer portion of the boss. To raise a load the handle is turned forward. This causes the handle to engage with the forward face at the end of the gap, and the drum to be turned on the shaft until the lug in the hole of the handle comes against the forward face of the slot in the shaft, when the drum and shaft will revolve as one. To unwind the drum, the handle is turned in the opposite direction. In this case the lug in the boss of the handle first bears against the forward face of the slot in the shaft, and forces the drum inward, after which the drum and shaft revolve together. Immediately the handle is released, either during winding or unwinding, the tension on the cord causes the drum to be turned on the shaft and to be forced against the casing. This device is made by Bernard Metz, Great Winchester St., E. C., London, England.

ROPE DRIVE FOR MACHINE TOOLS.

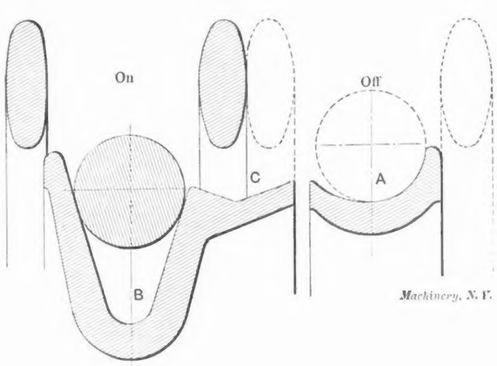
The Engineer (Chicago), July 15, 1907.

Hitherto rope drive has not been practical for machine tools of the variable speed type, such as lathes, shapers, drills, and drilling tools, because speed changes were usually procured by coned pulleys modified by throwing in or out the back gear. While a power rope can be shifted from one groove to

another, the operation is so tedious and time-consuming, that it cannot be applied to the often swiftly succeeding speed changes of modern machine shop practice. Hence belts have generally been used for these varying transmissions.

Of late, however, a number of single pulley drives have been introduced on tools of this class, in which speed changes are effected by lever-controlled change gears. This system has the great advantage of increasing the power delivered to the cutting tool by high initial belt speed. With a constant speed for the driving shaft, the cutting power is the same at high or low speed. Speed changes can be made very quickly, and a far greater range of changes can be obtained than with stepped pulleys. As the new design of speed changing is meeting with much favor among manufacturers on account of its advantages, and as transmission rope offers the ideal means for supplying power to constant speed shafts, we may look for a great increase in rope driving in future machine shop installations. This will result in marked economy of space, as the rim surface for rope sheaves is much less than that required for belting, which in turn means more rigidly supported shafts, as there will be less spring between the closer spaced bearings. It will also greatly decrease the noise of driving, and the loss of power from slipping. Properly laid and lubricated rope is not only much cheaper than belting, but requires no expense to speak of for dressing, lacing, cleaning and taking up slack.

Though we are not accustomed in this country to see driving rope shifted from an idle to a working pulley, it can be done just as well as with a belt, and is a matter of common occurrence in England. In a number of large cotton mills in the Lancashire district, the power is conveyed from a line shaft running the whole length of the room to numerous ring frames by means of ropes instead of belts, the ropes operating on fast and loose pulleys mounted within guard boxes.



Rope Drive for Machine Tools.

In this combination a shifting arrangement is used, illustrated in the cut, which could well be adapted for the drive of constant speed machine tools. The idle or loose sheave *A* has practically all of its flange cut away on the side towards the working of fast sheave *B*. To throw the machine into action, a curved rope shifter or fork is used, shown in section in the cut. It is bent to the curve of the sheave with very small clearance above the sheave flanges, and is operated with a pivoted hand lever. Referring to the cut, as the arm of the fork engages the driving side of the rope, it pushes the latter clear of its reduced flange onto the intermediate groove *C*, cut in the fast sheave. The shifter continuing toward the left, presses the rope into the groove *B*, whence it is readily forced out by reverse movement of the fork whenever the machine is to be stopped.

One objection is that to secure sufficient speed, the sheave on the lathe would have to be so small in diameter that quite a number of ropes would have to be used, which would make the face of the sheave as wide, if not wider, than a belt pulley for the same power. As the drive contemplates a lathe equipped with gears for changing speed, this objection falls away because one single rope can carry a great deal of power to a tool provided with a large sheave, and as gearing is going to be used anyhow, the speed of the first driver shaft can be varied at will. That almost any machinist can lace a belt, whereas practically none can splice a rope is an objectionable feature of constantly diminishing weight, because in the first place a rope does not need to be spliced nearly as often as a belt needs to be laced, and with the rapidly increasing use of transmission rope, the practice is growing of having at least one expert drive rope splicer attached to each large industrial establishment.

METAL AND RAW HIDE PINIONS FOR MOTOR DRIVES.

Wilfrid L. Spence, in *The Mechanical Engineer*, July 13, 1907.

In regard to the question of pinions, ordinarily a raw hide or paper pinion is much better than a metal one. Both materials named, apart from their surroundings, are utterly unmechanical; they depend absolutely on outside support to carry load, and whenever axial compression is relieved, the teeth bend over, lose their true form, become noisy, and rapidly deteriorate unless the load is light out of all proportion to dimensions. The weak point of most built pinions is the shrouding—the side plates are not usually stout enough to hold the hide or paper up to its work.

The very few failures (all several years ago) out of an extremely large number of applications of which the author has cognizance, were due to thin side plates necessarily accompanied by inadequate compression. This question is, of course, very much one of the point of view, for if, as indicated, the general wheel dimensions are chosen so large that the tooth load is light, then correspondingly lighter side plates may answer, but unquestionably that is expensive design. The author's practice, which has been quite successful in respect of smallness of wear, has commonly been to load the pinion as if it were of cast iron, and under such conditions the standard side plates are not adequate. Without being able to justify it theoretically, he has found that the empirical formula

$$t = 0.5\ P + 0.025\ \sqrt{D} + 0.25 \text{ inches,}$$

where

t = thickness of side plate, in inches,
P = circular pitch of teeth, in inches,
D = pitch diameter of pinion, in inches,

agrees closely with heavily loaded successful pinions designed in a wide range of sizes by eye—*i. e.*, to look right mechanically when drawn out full size.

In the design of any pair of motor gears the determination of the ratio, width of face to pitch of teeth, is of prime importance. For cheapness, the ratio must be small; for every other consideration it should be large. The old mill-wrighting proportion of 3 to 1 or thereabout, appropriate with cast wheels, is inadequate to meet present-day requirements, and it is no uncommon thing to find the working width of wheels equal to or greater than six times the circular pitch. The problem is to find a mean between the cheap, but noisy, and the more expensive silent wheels. The determining factor is the peripheral velocity in ordinary wheels and the speed of meshing in complex forms. Starting with a minimum ratio of 3 to 1 for no velocity, ending with $6\frac{1}{2}$ to 1 for 2,500 feet per minute, and aiming at between 5 and $5\frac{3}{4}$ to 1, which are known to be good proportions for the range of moderate speeds ordinarily met with, the author sketched out some years ago a curve to systematize his work. This curve agrees with

$$R = 3 + 0.05\ \sqrt{V}$$

where

R = ratio of wheel face to pitch of teeth,
V = peripheral velocity or speed of meshing in feet per minute.

This rule is again empirical, and has no other justification than that it agrees with a lot of successful and economical examples, and cannot in any case be very far from basic fact. In applying it the limitation of available shaft length has to be kept in view, as also the possibility that with great overhang an outer bearing may be necessary.

Regarding the strength of, or permissible loads on, spur gear teeth, the writer has for many years used with complete success the methods of Wilfred Lewis, and would confidently recommend their adoption to those who, and their number is legion, in the design of gearing have hitherto relied

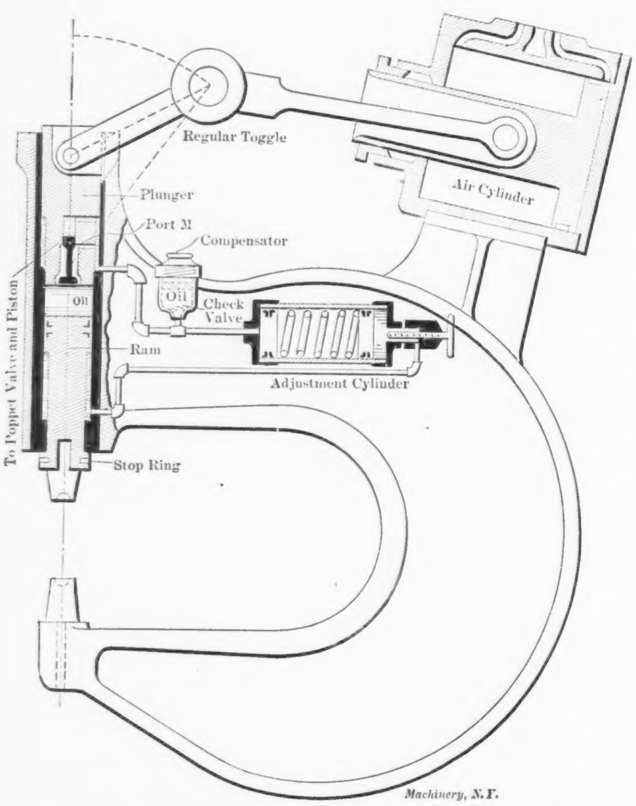
on mill-wrighting data which take no account of either peripheral velocities or of the number of teeth as affecting the permissible tooth load.

[The Lewis formula and tables for the strength of gear teeth are given in the following MACHINERY DATA SHEETS: No. 22, July, 1903; No. 62, October, 1906; and No. 64, December, 1906.]

SOME LATE IMPROVEMENTS IN COMPRESSIVE RIVETERS.

Paper read before Engineers' Society of Western Pennsylvania by Chester B. Albree.

The comparative advantages of the various forms of compressive riveters—hydraulic, hydro-pneumatic, direct pneumatic and pneumatic toggle-joint—have been considerably discussed and are fairly well understood. Each of them has certain advantages not possessed by the other. In a paper read by Mr. Chester A. Albree before the Engineers' Society of Western Pennsylvania is described a new riveter in which some of the advantages of the various forms are combined,



Pneumatic Toggle-joint Riveter, with Automatic Adjustment for Thickness of Work.

together with some additional improvements not hitherto attained. This riveter has the action of the toggle-joint type, with its increasing pressure towards the end of the stroke, where pressure is most needed in heading the rivet. It also has the valuable feature of the plain hydraulic machine in not requiring adjustment of the riveting jaws for work of different thicknesses. The machine is self-adjusting in this respect, and always gives the same terminal pressure, even though the thickness riveted may vary from one stroke to another. The following paragraphs are a digest of the paper referred to.

In the cut is shown the perfected form. The piston in the air cylinder is connected to the plunger by a toggle mechanism of the usual construction. The pressure from the toggle is transmitted to the top of the ram and also through a pipe to the adjusting cylinder. The ram being small in area and free to move, advances rapidly and continues until the rivet die on its extension strikes the projecting rivet. As the plunger continues, the pressure in the cylinder is limited by the pressure due to the spring in the adjusting cylinder, there being free communication to it through port *M* and the pipe shown. This pressure is only 20 pounds per square inch, insufficient to upset the rivet beneath the ram. Hence the liquid will now displace the piston in the adjusting cylinder, the ram remaining stationary.

Referring to the cut it will be noted that the extension of the plunger, when fully up, still projects into the smaller area of the ram cylinder; and that cup leathers are used to pack it. In the interior of this extension is a valve of the poppet type, but having a stem carrying on its end a small piston. This valve is normally held open by a spring. So long as the pressure above and below this small piston is the same, the spring holds the valve open, but when the pressure below is greater than above the piston will move up, closing the poppet valve. This occurs only when the port *M* leading into the space below the small piston is closed, due to its passing from the large diameter bore to the smaller ram bore. When closed, the toggle pressure acts on the liquid below the plunger extension, raising the pressure sufficiently to move the small piston and connected valve, and later exerting very high pressure on the poppet valve, shutting it perfectly tight.

During the downward motion of the ram the liquid beneath it is forced into the opposite end of the adjusting cylinder, against the spring pressure. It is obvious that the ram may move its whole adjusting stroke, or not at all, up to the time when port *M* is closed by entering the smaller diameter of the cylinder; after which the further travel of the ram is that of the plunger, until the ram meets opposition greater than the pressure of the toggle, when it will stop. This arrangement, therefore, automatically adjusts the point of maximum pressure to suit the work. On the return stroke we have the direct pressure beneath the ram, as well as the suction of the plunger, to raise the ram to its original position.

Leakage of the liquid is made up from a small storage, or compensating cylinder, full of liquid, having a piston with a spring behind it, connected to the larger bore of the plunger by a pipe, having a check valve in it. Whenever there is pressure in the plunger cylinder, the check valve remains closed; but when the toggle is fully back, and the piston in the adjusting cylinder is against its cylinder head, so that no pressure due to its spring is exerted on the liquid, any loss of liquid will tend to create a vacuum in the plunger cylinder, and then the check valve will open, and oil flow out of the compensating cylinder, under the pressure of the spring acting in its piston, to replace that lost.

This riveter is built by the Chester B. Albree Iron Works, Pittsburg, Pa.

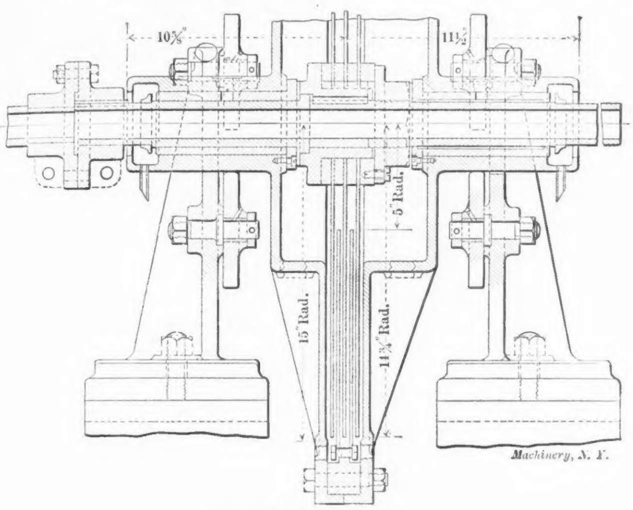
ABSORPTION DYNAMOMETER.

Engineering, May 31, 1907.

A novel form of dynamometer, made by Peter Brotherhood, Belvedere Road, Westminster Bridge, S. W., London, England, is illustrated in the cut herewith. This device is intended for comparatively high speeds, say from 300 to 1,200 revolutions, and is specially suitable for the testing of petrol motors, but its uses extend to the testing of motors of all classes. It is self-contained and independent, and may be made portable and be used anywhere, provided only that a supply of water is available. The dynamometer has been designed to supersede the unreliable and crude brakes of the Prony type, and at the same time to avoid the necessity of external appliances, and consequent complications of calibration associated with electrical and other forms of absorption brakes. As regards electrical testing sets, those most extensively in use require external resistances, volt and ammeters, etc., for the proper adjustment and reading of the load, and all these parts are liable to damage and deterioration. In the form of brake illustrated, there is no part liable to injury through neglect or rough usage, and the only external fittings required are flexible pipes for water supply, and a spring balance. Further, all the work given to the brake is definitely recorded, and no losses have to be reckoned. The principle employed is that of skin friction between plates and moving water.

The apparatus consists of a cast iron casing carrying long trunnions, supported on friction disks or ball bearings, about which the casing is free to rotate within limits. An arm, not shown in the cut, which is attached to the casing and projects to a fixed distance from the center, carries a spring balance to register the turning effort of the casing. The

shaft runs in bronze bushes in the trunnions, and carries one or more smooth disks of steel plate, of a diameter sufficient to occupy nearly the full diameter of the interior of the casing, there being placed between each pair of plates a ring of similar plate fixed in the joint of the casing. The fixed and revolving disks are separated and never come into contact. The brake is partially filled with water, and on the disks rotating, the water is carried out to their extreme edges, rotating with the disks, but at a slower speed. The energy of the motor under test is entirely dissipated by the friction of the fluid against the fixed and moving plates. The moment of this force tends to rotate the casing about the trunnions, the effort being measured by the spring balance fixed to the arm. It is evident that any friction of the



Absorption Dynamometer.

water, as well as of the shaft bearings, is duly shown on the spring balance, and the readings, therefore, always give a true record of the work given to the brake.

The water is introduced at the center of the casing, through a regulating cock, and drawn off at the rim. The quantity of water is adjusted, when the brake is in use, by a tube which may be set to project inward to any point toward the center of the shaft. The water inside this radius is discharged by centrifugal force, thus regulating the depth of the ring of fluid round the periphery of the disks. With a given quantity of water in the casing, and at all but the very lowest speed, the torque on the casing bears a fixed relation to the speed of rotation of the shaft, so that by increasing or reducing the water contents any conditions of torque and speed can be obtained.

MILLING MACHINE OUTPUT.

P. V. Vernon, in *The Engineer*, (London), May 31, 1907.

The reputation of the milling machine as a metal removing tool for enginering work is spreading, and it is, therefore, important to ensure that further progress shall be along the right lines. It is with this object that the following observations are offered, not with any intention of advocating a particular type of machine, but to note some of the conditions to be observed if the best output is to be obtained from any reasonably well designed machine.

The early milling cutter was called a fraise from a fancied resemblance of the toothed surface of the cutter to the rough exterior of the strawberry, and it may be owing to this that many milling machines are operated so as not to remove much more material than could be rubbed off with a hardened steel strawberry, instead of a properly designed milling cutter. The fact that each tooth is a cutting tool, with capacity for removing metal in much the same way as other metal-cutting tools, has been obscured by the association with it of many similar teeth on the same cutter, very little inquiry being made, as a rule, as to whether each tooth is doing fair duty, and the output of the cutter, as a whole, being judged by comparison with other milling cutters, and not by comparing the work of each cutting edge with that of other cutting edges of equal strength and with equal power behind them.

An examination into the question of the amount of cut taken by each tooth of a milling cutter shows that even when good milling, as generally understood, is being done, each tooth is taking a surprisingly small cut, and it is very seldom that the cutting edges fail through the heaviness of the cut when properly made and properly run. The accompanying Table I contains particulars of a number of milling cuts which are regularly performed, and which may be said to represent a good output (A. D. 1907) although not by any means the maximum possible output of the various cutters. It will be seen that although the feeds are fairly thick, yet the feed per tooth is quite small, and it may be fairly inferred that the cutters themselves might be made to do a great deal more work if other conditions permitted. The feeds are tabulated in three different ways, showing that the feed per tooth does not bear any fixed relation to the feed per minute, or to the feed per turn, neither of which, therefore, can be taken as a gage of the possibilities of output of the cutter, the feed per tooth and the cutting speed being the really important factors in the problem.

The usual limitations of output, when milling, are caused by spring or chatter due to weakness of the work, lack of driving power, weakness of the machine, or of the cutter arbor; weakness of the feed motion; weakness of the body of the cutter, not of the teeth; or insufficient room for chips. In order to get the maximum amount of work then from each tooth of the cutter, it is necessary to give attention to the following requirements, assuming that the work is massive enough to stand the heaviest cut that will be taken:—

(1) Sufficient driving power.
(2) A strong enough machine.
(3) A stiff enough arbor.
(4) A regular and powerful feed.
(5) Enough metal in the body of the cutter.
(6) Ample room for chips; in other words, teeth of coarse pitch.

I have no hesitation in stating my belief that the above six factors have very much more influence on the output of a milling cutter than the actual power of the tooth to resist the stresses that come on it. In order to determine the importance of each of these six vital factors in relation to the work of the cutter, it is best to consider them one at a time.

1. *Sufficient Driving Power.*—The maximum power deliverable to the machine is merely a matter of dimensions of its driving parts, but a much more important matter is the power available at the cutter on the different spindle speeds. The accompanying torque diagram is for a modern milling machine of cone pulley type, with all the latest improvements in the way of wide belts, large pulleys and double back gears, and it will be seen that the actual torque or driving effort available at the spindle varies in a more or less irregular manner. Now, assuming the number of teeth in cutting contact with the work to be constant, the torque required for a given cut per tooth is perfectly regular, and varies directly as the width of cut and as the diameter of the cutter. It is, therefore, important when doing fast milling to select a cutter of such diameter that, when running at its correct cutting speed, its driving torque will not be at the bottom of one of the valleys of the curve in the cut unless the power of the machine is enough to give ample torque even in the deepest valley. Subject to this and other reservations to be dealt with later, the diameter of the cutter should be as small as possible.

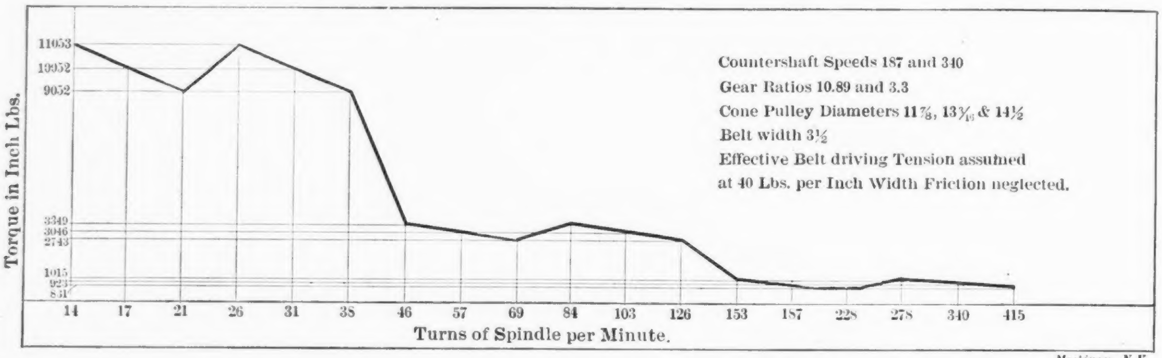
2. *A Strong Enough Machine.*—That is to say, a machine of which the frame, spindle, slides, and other parts are sufficiently strong to enable the whole of the driving power provided to be utilized at the cutter without chatter, flexure, or vibration. This factor is one of correct proportion, not of absolute dimensions, and a single faulty element will seriously affect the work of the cutter.

3. *A Stiff Enough Arbor.*—A milling cutter arbor must be strong torisionally and transversely, as the arbor is the only connection between the cutter and its driving power. In general terms, it may be said that arbors for heavy milling are often too small to transmit the power which the milling ma-

chines possess, and which the cutters could utilize but for the weakness of their arbors. The torsional stress on the arbor due to driving a given cut varies directly as the diameter of the cutter, whereas both the torsional and the transverse strength of the arbor vary directly as the cube of the diameter. It therefore pays in many cases to increase the diameter of the cutter, provided that the increase in diameter is also added to the arbor. The arbor, in fact, gains very much more than the cutter loses by the increase. Arbors should therefore be large.

4. *A Regular and Powerful Feed.*—The general experience of milling machine makers has decided in favor of a screw feed for heavy milling. It is not necessary to enlarge on various methods of feeding in this article, as the matter has been fully dealt with previously. It is enough to say that the feed must be sufficient in rate and in power to give as much feed to each tooth of the cutter as the other conditions will allow.

5. *Enough Metal in the Body of the Cutter.*—This condition further modifies the general maxim that cutters should be as small as possible. It is often desirable to make the cutter solid, so as to perform the double function of cutter and arbor. This may be said to give the smallest possible cutter with the largest possible arbor. Where, for reasons of cost or interchangeability, this cannot be done, ample thickness should be allowed, as nothing is gained in output by the use of a cutter so thin that it will not survive the maximum cut which the tooth will stand, which the arbor will transmit, and which the machine will drive.



Variation of Torque with Change of Speed in a Modern Cone Pulley Driven Milling Machine.

TABLE I. OUTPUT OF MILLING CUTTERS.

Cutter.				Cut.		Speed.		Feed.			Material Removed.	Material Milled.
Type.	Steel.	Diam., in.	No. of Teeth.	Width, in.	Depth, in.	Turns per min.	Feet per min	Inches per min.	Inches per turn.	In. per tooth.	Cubic in. per min.	
Face	High speed	2	12	1.125	0.187	200	105	9	0.045	0.0038	1.9	Cast iron
"	"	3½	12	2.625	0.187	86	79	5.5	0.064	0.0053	2.7	"
"	"	4½	14	3	0.156	60	71	8.5	0.140	0.0100	3.98	"
"	"	6½	16	5	0.125	41	70	10.3	0.252	0.0157	6.45	"
"	"	8	12	8	0.125	30	63	5.87	0.195	0.0163	5.87	"
Side	"	2½	16	2.5	0.25	110	72	6.5	0.059	0.0037	4	"
"	Carbon	2¾	12	3	0.125	48	34 5	12 125	0.253	0.0214	4.55	"
"	High speed	3	8	5	0.312	60	47	12	0.200	0 025	18.7	"
"	Carbon	2¼	18	1.875	0.1	64	38	3.3	0.051	0.0029	6.2	Mild steel
"	High speed	2¾	22	3.5	0.187	48	35	3.5	0 073	0.0033	2.3	"
"	"	3⅞	18	1.75	0.75	64	65	1.375	0 0215	0.0012	1.8	"

6. *Teeth of Coarse Pitch.*—A milling cutter will do more work when each tooth gets well under the surface; in other words, when the feed per tooth is sufficient to enable a cut rather than a scrape to be taken. With coarse pitch cutters, less teeth are cutting at one time, and a given feed power is more effective on each tooth than in the case of fine pitch cutters. There is also more room for chips. The space per tooth available for chips varies approximately as the square of the pitch of the teeth, and the total space for chips all round the cutter varies directly as the pitch. Coarse pitch cutters can also have stronger teeth than fine pitch cutters, as they permit of a wider land behind the cutting edge, without unduly robbing the space available for chips, and incidentally the thicker tooth is not so easily affected by heat generated while cutting. In addition to this, the thicker chips taken by coarse pitch teeth occupy less space in proportion to their weight than thin chips, thus further favoring the coarse pitch cutter. Most of the published tables of milling cutter dimensions specify too many teeth in the cutters, and users of modern machines will be well advised not to rely on such tables, but to favor very much coarser pitches.

The following table has been found satisfactory for general use, but is put forward more as a suggestion than with the idea that it is a final statement of ultimate possibilities:

TABLE II. NUMBER OF TEETH IN MILLING CUTTERS.

Diameter of Cutter.	No. of Teeth, Ordinary Finishing and Roughing Cutters.	No. of Teeth, Cutters for Heavy Roughing only.
⅛ in. to 3-16 in.	5	—
¼ in. to 13-16 in.	6	—
⅞ in. to 1¼ in.	8	—
1⅜ in. to 1½ in.	9	6
1⅝ in. to 1⅞ in.	10	6
2 in. to 2¾ in.	12	7
2½ in. to 3¾ in.	14	8
3½ in. to 3⅞ in.	16	9
4 in. to 6 in.	18	10

With roughing cutters made as per the last column, only one tooth will be cutting at a time on all ordinary roughing work. The spiral must, therefore, be such as to ensure continuity of torque, or the result will be an intermittent cut. A good angle of spiral for general work is 27 deg. with the axis of the cutter. It must not be forgotten that coarse pitch of teeth necessitates short pitch of spiral.

There are many more questions in connection with milling, on which definite information is required, if milling is to take its proper place in the economy of the machine shop, such as the effect of the feed per tooth on the cutting speed for different materials, the proper cutting and clearance angles for milling cutter teeth, and the proper ratio between power consumed and metal removed under the best conditions; but enough has perhaps been said to indicate that there may be points in connection with milling which do not receive attention from the average user, and that the successful use of milling machines depends upon a proper appreciation of these points. The labor-saving possibilities of milling machines properly designed, built, tooled, and handled, are perhaps greater than of any other metal cutting tools, and it is for the present generation of engineers to avail themselves of these possibilities to the fullest extent.

COOPERATIVE COURSES IN ENGINEERING AT THE UNIVERSITY OF CINCINNATI.

Abstract of Paper by Prof. Herman Schneider, read before the Society for the Promotion of Engineering Education.

The plan of combined theoretical and practical instruction, followed in the mechanical engineering course of the University of Cincinnati, was described in the March, 1907, issue of MACHINERY under the title "Unique Experiment in Technical Education." The paper, of which this is an abstract, gives further information as to the plan of this course, and tells something of the success that has attended it so far.

About six years ago the writer began what might be called a pedagogical research into the problem of engineering education. After a time he sifted the problem down to three question:

What requirements should the finished product of an engineering school fill?

Where and how shall we get the raw material to make the required finished product?

Through what process shall we put the raw material, in order to acquire the finished product?

The thorough investigation of these questions, carried on by visits to the largest manufacturing concerns in the Eastern and Middle States for six years, and still in progress, resulted in certain conclusions which seemed so radical that the writer hesitated to promulgate them until they had been actually tested. The present six-year course at the university is the outgrowth of these investigations, and it seems to have worked well enough so that the writer feels warranted in giving more publicity to the idea.

The length of the course is six years. During this period the students work alternate weeks in shops of the city throughout the scholastic year, and in the summer full time. Two facts are emphasized in this connection. First, the entrance requirements are precisely the same as for the four-years course; second, the university instruction under the cooperative plan is just as complete, thorough, broad, and cultural as the four years course. In fact it is rather more so. The course is not a short-cut to salary.

Young men desiring to enter this course are required to enter the shops in June or July preceding their entrance to the university. The process of elimination takes place during the summer work, which weeds out the weaker and more undecided ones, and leaves a residue which can be depended on for results. Last year 60 young men made application for entrance, and 45 of them undertook the shop work after learning the conditions of the course. Fifteen of these quit after they began, leaving a class of 30 in September. Three of these men have been dismissed for poor scholarship. This year about 400 inquiries and applications for admission to the course were received. Most of these faded away when they learned of the conditions. Up to this writing, 50 men had been placed in the shops for this year's class. There will probably be between 50 and 75 when the class is formed.

It is interesting to note the reasons which prompted these young men not to apply for work, or if they did apply, to quit work. Some of the reasons were: "It looked too hard"; "I had to get up too early in the morning"; "the work was too greasy"; "I'd rather be a lawyer"; "I want to complete my education in four years instead of six"; "my father said they did not pay me enough"; "my mother was afraid I'd get killed'"; "the boss spoke gruffly to me"; and so on. Some of the young men who withdrew from the cooperative course are in the four-year course.

A comparison of the work of the four-year freshman with that of the six-year freshman is interesting. The six-year cooperative students, though but working half the time of the regular students, have accomplished three-fourths of the work done by them, including all the mathematics and science of the freshman year. The course has been applied to the department of electrical, chemical and mechanical engineering. Attention is called to the fact that under this scheme the college is operated at the highest efficiency. Being given a certain sum of money to train a certain number of men, only those who by mental, physical and temperamental adaptability are worthy of the expenditure made, are retained.

[A recent report from the Cincinnati University states that nearly 60 young men have undertaken the course this year. This is double the number that began last year. About half of them are from Cincinnati and its immediate vicinity, the balance coming from all over the United States, as far west as Idaho, and as far east as Connecticut. The machine shops of the city appear to be much interested in the work, and enter into hearty cooperation with the University.]

COMPARATIVE COSTS OF GASOLINE, GAS, STEAM AND ELECTRICITY FOR SMALL POWERS.

William O. Webber, in *Engineering News*, August 15, 1907.

The comparative cost of the various sources of power is a matter of very great interest in installations of small power where any one is equally available and the sole determining factor is expense. In the usual determination of these relative costs it has been assumed that the total cost of a new plant was merely the cost of the machine plus the cost of the material required to run it, and that the additional cost of depreciation, interest, insurance, etc., would be the same in each instance. It is also generally assumed that the power costs just so much per horse-power regardless of the amount used. These are both very erroneous impressions.

The following tables give the itemized cost of 1 horse-power per hour on 2, 6, 10 and 20-horse-power plants, respectively, for gasoline, gas, steam and electric power.

Table I shows the cost of gasoline power, and is based on fact, not theory. All gasoline engines do not run on one-eighth of a gallon of gasoline per brake horse-power per hour, and to get at fair comparative results, proper allowances must be made for depreciation, repairs and insurance, as well as taxes, and the room occupied by the plant must be taken into account.

Table II shows the costs for the same powers driven by electricity It will be noted that proper allowance must be made for attendance, although this item is not generally charged as it should be. In this case nothing is charged for room, as separate power rooms are not required.

Table III gives the cost of gas power, using illuminating gas of 760 B. T. U. No estimate is made on the cost of gas power, using producer gas, as it would not pay to put in a gas producer for so small a unit.

In Table IV are given figures on the cost of steam power, from 6 to 20 horse-power, but no estimate is made on the cost for 2 horse-power, for the reason that such a plant would be too small to consider. The figures in Table V show a summarized comparison between the annual cost of power per brake horse-power for various kinds of motive power.

TABLE I. COST OF GASOLINE POWER.

Size of plant in H.P.	2	6	10	20
Price of engine in place	$150.00	$325.00	$500.00	$750.00
Gasoline per B.H.P. per hour	1-3 gal.	1-4 gal.	1-6 gal.	1-8 gal.
Cost per gallon	$0.22	$0.20	$0.19	$0.18
= cost per 3,080 hours	$451.53	$924.00	$975.13	$1,386.00
Attendance at $1 per day	308.00	308.00	308.00	308.00
Interest, 5%	7.50	16.25	25.00	37.50
Depreciation, 5%	7.50	16.25	25.00	37.50
Repairs, 10%	15.00	32.50	50.00	75.00
Supplies, 20%	30.00	65.00	100.00	150.00
Insurance, 2%	3.00	6.50	10.00	15.00
Taxes, 1%	1.50	3.25	5.00	7.50
Power cost	$824.03	$1,371.75	$1,498.13	$2,016.50

To these figures should be added charges on space occupied as follows:

Value of space occupied	$100.00	$150.00	$200.00	$300..0
Interest, 5%	$5.00	$7.50	$10.00	$15.00
Repairs, 2%	2.00	3.00	4.00	6.00
Insurance, 1%	1.00	1.50	2.00	3.00
Taxes, 1%	1.00	1.50	2.00	3.00
Total annual charge for space	$9.00	$13.50	$18.00	$27.00
Total cost per annum	$833.03	$1,385.25	$1,516.13	$2,043.50

Cost of 1 H.P. per annum, 10 hour basis	416.51	239.87	151.61	102.17
Cost of 1 H.P. per hour	$.1352	$0.0780	$0.0492	$0.0331

TABLE II. COST OF ELECTRIC POWER.

Size of plant in H.P.	2	6	10	20
Cost of motor in place	$83.00	$118.00	$216.00	$270.00
With wiring, etc.	100.00	130.00	240.00	300.00
Cost of electricity 3,080 hours	$529.56	$976.00	$1,425.00	$2,450.00
Attendance	20.00	30.00	50.00	50.00
Interest, 5%	5.00	6.50	12.00	15.00
Depreciation, 10%	10.00	13.00	24.00	30.00
Repairs, 5%	5.00	6.50	12.00	15.00
Supplies, 1%	1.00	1.30	2.40	3.00
Insurance, 2%	2.00	2.60	4.80	6.00
Taxes, 1%	1.00	1.30	2.40	3.00
Total cost per annum	$573.56	$1,037.20	$1,532.00	$2,572.00
Cost of 1 H.P. per annum, 10 hour basis.	286.78	172.86	153.20	128.60
Cost of 1 H.P. per hour	$0.0928	$0.0558	$0.0497	$0.0417

The costs for the electric current which are used in Table II are figured from the discount table shown as follows:

COSTS OF ELECTRIC CURRENT.

Base Price $= 13\frac{1}{2}$ cents per K.W. hour. Discounts on Monthly Bill.

Monthly Bill.	Discounts.	Monthly Bill.	Discounts.
$5	10%	$100 to $125	40%
$10 to $20	15%	$125 to $150	45%
$20 to $25	20%	$150 to $175	50%
$25 to $50	25%	$175 to $200	55%
$50 to $75	30%	$200 to $500	60%
$75 to $100	35%	$500 and over	65%

For 2 H.P. plant:

$$\frac{3{,}080 \text{ hours} \times 2 \text{ H.P.} \times 0.746}{82 \text{ per cent Efficiency}} = 5{,}604.1 \text{ K.W. hours per annum,}$$

then $5{,}604.1 \times \$0.135 = \$756.55$, annual cost without discount. Monthly bill $= \$63$. Discount $= 30$ per cent.

$\$756.55 \times 70\% = \$529.56 =$ annual cost.

For 6 H.P. plant:

$$\frac{3{,}080 \text{ hours} \times 6 \text{ H.P.} \times 0.746 \times 0.135 \times 45}{86 \text{ per cent Efficiency}} = \ldots\ldots\ldots \$976.00$$

Monthly cost $= \$180$. Discount $= 55$ per cent.

For 10 H.P. plant:

$$\frac{3{,}080 \times 10 \times 0.746 \times 0.135 \times 40}{87 \text{ per cent}} = \ldots\ldots\ldots \$1{,}425.00$$

Monthly cost $= \$298$. Discount $= 60$ per cent.

For 20 H.P. plant:

$$\frac{3{,}080 \times 20 \times 0.746 \times 0.135 \times 35}{88.5 \text{ per cent}} = \ldots\ldots\ldots \$2{,}450.00$$

Monthly cost $= \$585$. Discount $= 65$ per cent.

TABLE III. COST OF GAS POWER.

$1.50 per 1,000 cubic feet of gas less 20 per cent, if paid in 10 days = $1.20 net, gas 760 B. T. U.

Size of plant in H.P.	2	6	10	20
Engine cost in place	$200.00	$375.00	$550.00	$1,050.00
Gas per H.P. hour in cubic feet	30	25	22	20
Value of gas consumed, 3,080 hours	$221.76	$554.40	$843.12	$1,478.00
Attendance, $1 per day	308.00	308.00	308.00	308.00
Interest, 5%	10.00	18.75	27.50	52.50
Depreciation, 5%	10.00	18.75	27.50	52.50
Repairs, 10%	20.00	37.50	55.00	105.00
Supplies, 20%	40.00	75.00	110.00	210.00
Insurance, 2%	4.00	7.50	11.00	21.00
Taxes, 1%	2.00	3.75	5.50	10.50
Power cost	$615.76	$1,023.65	$1,387.62	$2,237.50
Annual charge for space	9.00	13.50	18.00	27.00
Total cost per annum.	$624.76	$1,037.15	$1,405.62	$2,264.50
Cost of 1 H.P. per annum, 10-hour basis.	312.38	172.86	140.56	113.22
Cost of 1 H.P. per hour	$0.1014	$0.0561	$0.0456	$0.0367

TABLE IV. COST OF STEAM POWER.

Size of plant in H.P.	6	10	20
Cost of plant per H.P.	$250.00	$220.00	$200.00
Fixed charge, 14%	$35.00	$30.80	$28.00
Coal per H.P. hour, in pounds	20	15	12
Cost of coal at $5 per ton	$154.00	$103.00	$82.50
Attendance, 3,080 hours	75.00	50.00	30.00
Oil, waste and supplies	15.00	10.00	6.00
Cost 1 H.P. per annum, 10-hour basis	$279.00	$194.80	$146.50
Cost of 1 H.P. per hour	$0.0906	$0.0832	$0.0475

TABLE V. ANNUAL COST OF POWER PER BRAKE HORSE-POWER.*

B H.P. of Unit.	Steam	Electricity.	Gas.	Gasoline.
1	$600.00	$312.50	$380.00	$487.50
2	500.00	282.00	312.50	416.00
3	437.50	252.00	260.00	350.00
4	375.00	227.50	220.00	300.00
5	320.00	207.50	192.50	262.50
6	280.00	192.00	172.50	240.00
7	250.00	179.00	160.00	210.00
8	230.00	168.00	152.50	182.50
9	210.00	158.00	145.00	165.00
10	195.00	152.00	140.00	152.00
12	175.00	140.00	132.50	137.50
14	165.00	133.00	126.00	122.00
16	157.50	128.00	120.00	112.50
18	150.00	126.00	116.50	107.50
20	146.00	123.00	113.00	102.00
22	140.00	121.50	110.00	98.00
24	137.50	119.50	107.50	95.00
26	133.00	117.50	105.00	92.50
28	130.00	116.50	102.50	90.00
30	127.50	115.00	102.00	87.50
35	124.00	113.50	100.00	85.00
40	120.00	112.00	98.00	82.50
50	112.50	110.00	96.00	80.00
60	105.00	108.00	94.00	78.00
70	100.00	106.00	92.00	76.00
80	95.00	104.00	90.00	74.00
90	90.50	102.00	88.00	72.00
100	86.40	100.00	86.00	70.00

* Unit costs: Coal, $5 per ton; electricity, $0.135 per K.W.-hour; gas $1.20 per 1000 cubic feet, at 760 B. T. U.; gasoline, $0.20 per gallon.

* * *

UNUSUAL POWER HOUSE.

The most unusual power house of which we have ever heard has recently been completed for the Patapsco Electric & Mfg. Co., Ilchester, Md. This power house is located inside of a dam. The dam is of reinforced concrete and hollow, leaving a considerable amount of waste room which it seemed advisable to make use of in some way. The installing of the turbines and generators in this space reduced materially the cost of the installation, resulting in shorter and more direct passages for the water, and less expense for buildings. The part of the dam used for housing the plant is fitted with a false ceiling, hung 5 feet from the main shell of the structure so as to protect the apparatus from any water that might leak through the deck. The side next to the tail water is fitted with windows. These windows furnish plenty of light, even when the water is flowing over the dam two feet deep. The water for operating the turbines is taken through the deck $5\frac{1}{2}$ feet below the crest of the spill-way. This helps to keep the trash rack free from drift wood, etc. Two waste gates are placed near the bottom of the dam, with the water passages under the floor.

* * *

According to the *Times Engineering Supplement*, Switzerland possesses in all about 1,000,000 horse-power of water power, which can practically be developed. Of this, one-fourth is already utilized, and new installations of large capacity are being erected for the purpose of generating electricity. The generating stations are situated in different places far apart from one another, but the districts served by the systems border on each other and can be connected with very little expense, so that if one generating station is short of power for one reason or another it can be supplied from another system, and *vice versa*. Thus, it is possible to supply current to one part of Switzerland from another part, and this, in general, improves the load factor of the generating stations.

FORMULAS FOR FORCE REQUIRED TO MOVE CRANE TROLLEYS.*

JOHN S. MYERS.†

In designing crane trolleys and similar constructions the force required to move them is not always calculated to a nicety, and the design then based upon the figures. This may be the conception of the man fresh from college, but it more frequently happens that past experience of a case similar to the one in hand is relied upon entirely.

This is both a safe and quick method, when conditions make it possible, provided good judgment is exercised in allowing for differences between the past construction and the proposed new one. The designer is, however, often confronted by a problem in which he has no past experience to draw upon and for which he has no applicable data at hand, or the design may be of a type similar to that of past experience, but so different as to sizes that he is compelled to calculate from elementary principles. Two troublesome questions then arise: First, what theoretical conditions should be taken into account and what ones may be safely neglected? and second, what values should be assigned to the various constants and assumed factors entering into the calculations? The practicability of his designs will depend almost entirely upon the manner in which the above questions are answered.

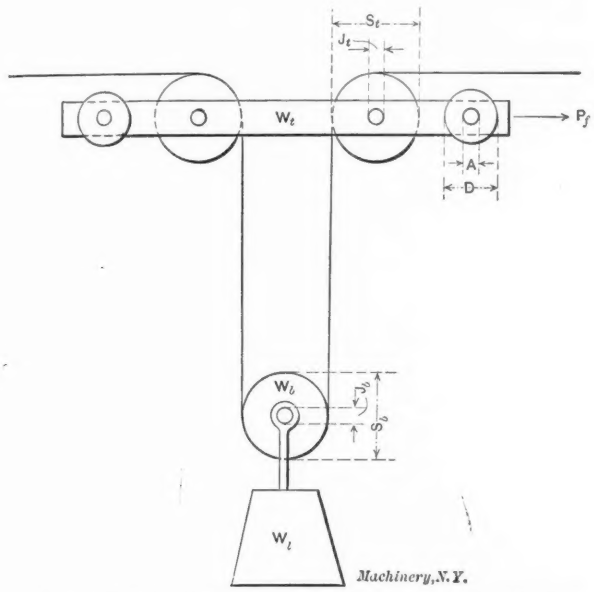


Fig. 1. Trolley with Sheave Suspended by Two Parts of Rope.

Taking up the subject of crane trolleys, of the type in which the load is suspended by ropes passing over sheaves in the trolley and hanging block, as illustrated in Figs. 1, 2, and 3, the above questions may be considered as mutually dependent upon each other, and might be answered as follows:

Take into account journal friction of the trolley wheels, trolley sheaves and hanging block sheaves; also the separate weights of load to be carried, hanging block, and trolley.

Neglect friction of ropes in grooves of sheaves, power necessary to bend ropes over sheaves, and the rolling friction of the trolley wheels on the track, allowing these to be taken care of by the assumed coefficient of journal friction.

Neglect inertia, also, for the usual speeds of crane trolleys, since the difference between the coefficient of rest and of motion is sufficient to produce the necessary acceleration.

In choosing the coefficient of friction consider the general conditions of lubrication as being poor, and consider that it is the coefficient of rest which is required. Assume this coefficient to be the same for all journals. A fair value is 0.1. Having settled these preliminary considerations, general formulas may be developed.

CASE 1. (See Fig. 1.) The conditions are: Two parts of rope supporting the load, one sheave in hanging block, and two sheaves in trolley.

* For previous articles on this and kindred subjects, see "The Efficiency of Mechanism," by Mr. C. F. Blake, March and April, 1908.

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Let W_l = weight of load to be carried.
W_b = weight of hanging block.
W_t = weight of trolley.
P_f = pull on trolley to overcome friction.
S_b = diameter of sheave in block.
J_b = diameter of journal in block.
S_t = diameter of sheave in trolley.
J_t = diameter of journal in trolley sheaves.
D = diameter of trolley wheels.
A = diameter of trolley axle journals.
C = coefficient of friction.
F_b = friction of hanging block sheave.
F_{ts} = friction if trolley sheaves.
F_{tw} = friction of trolley wheels.

For Case I,

$$F_b = (W_l + W_b)\, C \frac{J_b}{S_b} \qquad (1)$$

The load being supported by two ropes, the load in each is $\frac{1}{2}(W_l + W_b)$ and, the arc of contact of the rope on the trolley sheaves being 90 degrees (α) the resultant pressure on the journals of each of these sheaves is $\frac{1}{2}(W_l + W_b)\, 2 \cos \frac{\alpha}{2} = \frac{1}{2}(W_l + W_b)\, 2 \cos 45$ degrees.

For the two sheaves the resultant pressure amounts to

$$1.4\,(W_l + W_b).$$

From the above we get:

$$F_{ts} = 1.4\,(W_l + W_b)\, C \frac{J_t}{S_t} \qquad (2)$$

For the friction of the axle bearings of the trolley wheels, the weight of the load, hanging block, and trolley must be considered, thus:

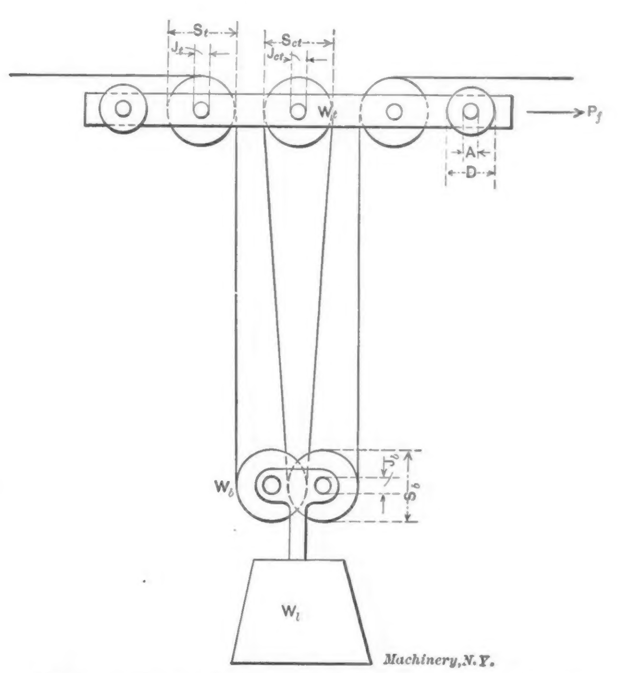


Fig. 2. Trolley with Sheave Suspended by Four Parts of Rope.

$$F_{tw} = (W_l + W_b + W_t)\, C \frac{A}{D} \qquad (3)$$

We have, then, for the total friction

$P_f = F_b + F_{ts} + F_{tw}$, or

$$P_f = C\left[(W_l + W_b)\left(\frac{J_b}{S_b} + 1.4\frac{J_t}{S_t}\right) + (W_l + W_b + W_t)\frac{A}{D}\right] \qquad (4)$$

CASE II. (See Fig. 2.) The conditions are: Four parts of rope supporting the load, two sheaves in the hanging block, and three sheaves in the trolley.

Let the notation be as for case I with the addition of:

S_{ct} = diameter of sheave at center of trolley.
J_{ct} = diameter of journal for this sheave.

Then, F_b = same as for case I (equation 1).
F_{tw} = same as for case I (equation 3).

The friction of the two end sheaves in trolley is one-half of that in case I or

$$0.7\,(W_l + W_b)\,C\,\frac{J_t}{S_t}.$$

The friction of the central sheave is

$$0.5\,(W_l + W_b)\,C\,\frac{J_{ct}}{S_{ct}}.$$

The total friction of the trolley sheaves is then

$$F_{ts} = (W_l + W_b)\,C\left(0.7\,\frac{J_t}{S_t} + 0.5\,\frac{J_{ct}}{S_{ct}}\right) \qquad (5)$$

The total frictional resistance of the trolley is:

$$P_f = F_b + F_{ts} + F_{tw} \text{ or}$$

$$P_f = C\left[(W_l + W_b)\left(\frac{J_b}{S_b} + 0.7\,\frac{J_t}{S_t} + 0.5\,\frac{J_{ct}}{S_{ct}}\right) + (W_l + W_b + W_t)\,\frac{A}{D}\right] \qquad (6)$$

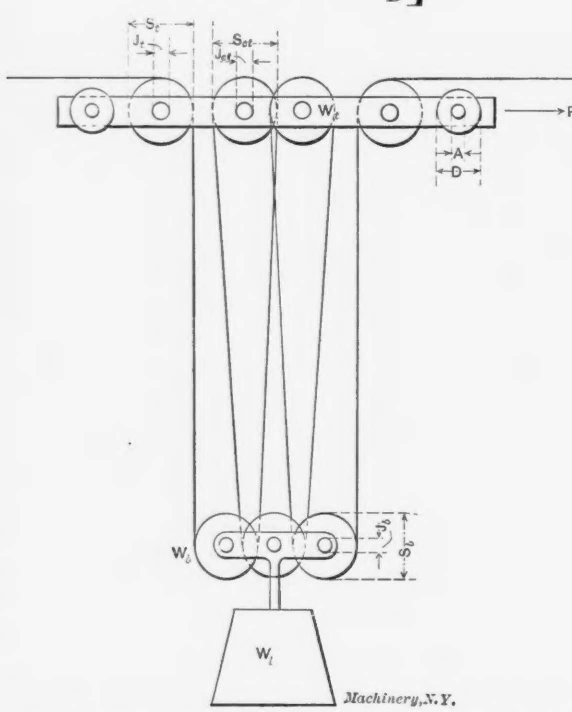


Fig. 3. Trolley with Sheave Suspended by Six Parts of Rope.

When $\frac{J_{ct}}{S_{ct}} = \frac{J_t}{S_t}$, as it often will be, equation 5 becomes:

$$F_{ts} = 1.2\,(W_l + W_b)\,C\,\frac{J_t}{S_t} \qquad (7)$$

Under these conditions equation 6 reduces to

$$P_f = C\left[(W_l + W_b)\left(\frac{J_b}{S_b} + 1.2\,\frac{J_t}{S_t}\right) + (W_l + W_b + W_t)\,\frac{A}{D}\right] \qquad (8)$$

Case III. (See Fig. 3.) The conditions are: Six parts of rope supporting the load, three sheaves in hanging block and four sheaves in trolley.

Notation the same as for cases I and II.

F_b = same as case I and II. (equation 1).

F_{tw} = same as case I and II. (equation 3).

The load in each rope is 1/6 $(W_l + W_b)$.

In case I the load in each rope was 1/2 $(W_l + W_b)$.

The frictional resistance of the two end sheaves is therefore $1/6 \div 1/2 = 1/3$ as much for this case as for case I, and is equal to $0.47(W_l + W_b)\,C\,\frac{J_t}{S_t}$. The friction of the two central sheaves is $2/3\,(W_l + W_b)\,C\,\frac{J_{ct}}{S_{ct}}$. The total friction of the trolley sheaves is then

$$F_{ts} = (W_l + W_b)\,C\left(0.47\,\frac{J_t}{S_t} + 0.67\,\frac{J_{ct}}{S_{ct}}\right) \qquad (9)$$

The total friction of the trolley is $P_f = F_b + F_{ts} + F_{tw}$, or

$$P_f = C\left[(W_l + W_b)\left(\frac{J_b}{S_b} + 0.47\,\frac{J_t}{S_t} + 0.67\,\frac{J_{ct}}{S_{ct}}\right) + (W_l + W_b + W_t)\,\frac{A}{D}\right] \qquad (10)$$

When $\frac{J_{ct}}{S_{ct}} = \frac{J_t}{S_t}$, as would usually be the case, equation 9 reduces to

$$F_{ts} = 1.14\,(W_l + W_b)\,C\,\frac{J_t}{S_t} \qquad (11)$$

Under this condition equation 10 becomes

$$P_f = C\left[(W_l + W_b)\left(\frac{J_b}{S_b} + 1.14\,\frac{J_t}{S_t}\right) + (W_l + W_b + W_t)\,\frac{A}{D}\right] \qquad (12)$$

If we assume that the ratio of journal diameter to sheave diameter is the same for all sheaves and also the same for the trolley wheels and their axle journals, *i. e.*, that $\frac{J_b}{S_b} = \frac{J_t}{S_t} = \frac{J_{ct}}{S_{ct}} = \frac{A}{D}$, or that this condition is approximately true, and let R = this ratio, the foregoing formulas for the value of P_f may be reduced to the following form:

For case I, $P_f = C\,R\,[3.4\,(W_l + W_b) + W_t]$ (13)

For case II, $P_f = C\,R\,[3.2\,(W_l + W_b) + W_t]$ (14)

For case III, $P_f = C\,R\,[3.1\,(W_l + W_b) + W_t]$ (15)

It is seen from the above that the friction is nearly the same for the three cases, provided the value of R be the same. Equation 14 being the intermediate condition may then be considered as representative of all.

* * *

UNIQUE MEANS FOR POWER PRODUCTION.

Mr. Frank Shuman, Tacony, Pa., has developed a power scheme that is attracting some attention. It works on the principle of the common hot-bed used for growing vegetables in winter, the heat rays of the sun being concentrated in exactly the same manner. The power hot-bed is 18 x 60 feet, and is covered by a double top of glass with 1 inch air space between the layers. In the bed are coils of iron pipe painted black. These pipes are filled with ether and are connected with a 3½-horse-power engine. The circuit is closed, the ether after having been evaporated in the pipes passing through the engine thence to a condenser and back to the hot-bed pipes. It is claimed by Mr. Shuman that this apparatus in the tropics could use water successfully as the high temperature acquired from the direct rays of the tropical sun would be amply sufficient to boil water under considerable pressure. It is probable, however, that this idea, while productive of small power, can scarcely be of any great commercial value because of the large investment necessary. Greenhouses might utilize the idea profitably if there is need of small power for pumping, etc., but to deliberately construct a power plant on this plan would seem quite out of the question.

* * *

The *Mining World* describes a new remedy for burns discovered by one Dr. Thierry, a physician in the Paris Charity Hospital. He was in the habit of using picric acid as an antiseptic, so that his hands were impregnated with the solution. One day in lighting a cigarette he dropped a portion of the burning match on his hand, but instead of it hurting him, he felt no pain whatever. A short while afterward, while sealing a letter, some of the burning wax stuck to his finger, and though it cauterized the skin, he felt nothing. He began a series of experiments in healing burns with a saturated solution of picric acid. All pain instantly was suppressed. After having bathed the wound in a solution of this acid, blisters did not form, and a cure was effected after four or five days. The only inconvenience was that the acid colored the skin yellow, but this is rapidly remedied by washing with boric acid. The cheapness of picric acid, and the ease with which a proper solution is prepared, have induced many Parisian manufacturers to place jars within easy reach of their workmen.

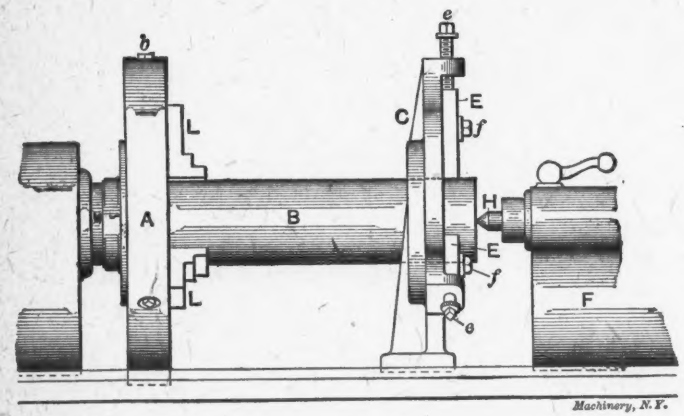
CUT OUT ON THIS LINE.

PUNCH O PUNCH O PUNCH O PUNCH O PUNCH O PUNCH. O

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

SHOP OPERATION SHEET NO. 16.

Oscar E. Perrigo. MACHINERY, October, 1907.



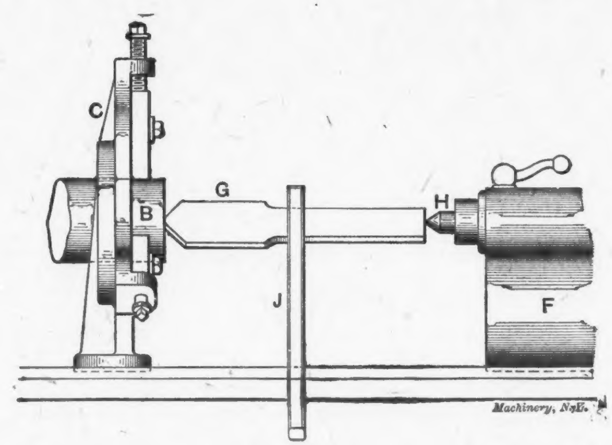
To Hold a Piece in Chuck and Center-rest (Steady-rest), for Drilling and Reaming.

1. Provide, if possible, a three-jawed chuck, the screws of which are connected by a ring bevel gear within the casing. This form is commonly known as a "universal" chuck.
2. Clean the threads of chuck and spindle, and screw the chuck firmly in place. Jaws *L* should preferably face as shown.
3. Lay off and prick punch the exact center of piece *B*.
4. Put the opposite end of *B* in the chuck jaws, and tighten screws *b* just enough to support the work in the chuck.
5. Set up center-rest *C* as shown, and clamp it in place; jaws *E* should not yet be in contact with work *B*.
6. Clamp tail-stock *F* in position as shown. Tap the free end of piece *B* until the prick-punch mark is brought to center *H;* then set up the tail-center just enough to hold the work in place.
7. Tighten the jaws of the chuck, in rotation, enough to hold the work firmly in place.
8. Bring the two lower jaws *E* of the center-rest up to a good contact with casting *B* by setting up jaw screws *e* lightly; then bring down top jaw *E*, clamping all three with nuts *f*.
9. Loosen the tail-stock *F*, run it back, remove center *H*, and replace it by any convenient form of centering or starting tool. Move up the tail-stock again, and clamp it as shown.
10. Start the lathe up slowly. Feed the centering tool by the tail-stock hand-wheel until a proper center is made.

Note.—The center-rest jaws must bear as firmly as possible and still permit the work to revolve. Keep the points of the jaws well oiled. For accurate work, the prick-punch mark should be drilled and reamed for a center hole, center *H* inserted, and a short space on the work turned to furnish a true bearing for the center-rest jaws.

SHOP OPERATION SHEET NO. 17.

Oscar E. Perrigo. MACHINERY, October, 1907.



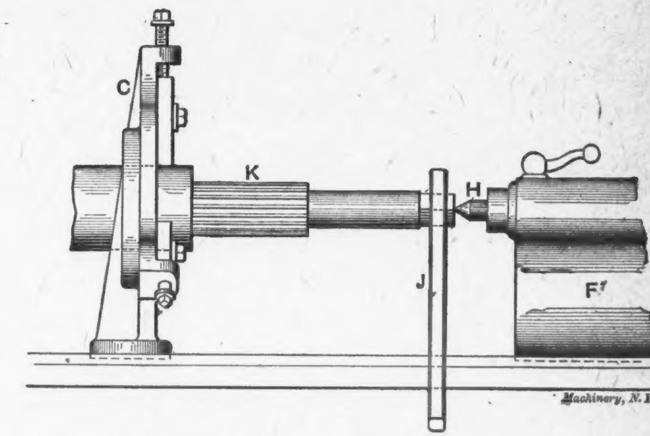
To Drill a Piece Held in a Chuck and Supported by a Center-rest.

1. With the work centered for the drill and properly mounted in chuck and center-rest, move tail-stock *F* to the position shown, and clamp it there, at the proper distance for the drill used.
2. Select a flat chucking drill *G*, about 0.005 inch smaller than the finished hole. Place it in position as shown, with its point in the hole made in the work *B* by the centering or starting tool, and with the tail-center of the lathe in the center-hole in the rear end of the drill. Place on the drill a drill-holder or wrench *J*, to prevent it from rotating when the lathe is started.
3. Start up the lathe and bore the hole as deep as desired, keeping the drill-holder *J* in place with the left hand, while feeding the drill by the tail-stock hand-wheel with the right hand. If the hole is deep, the drill must be occasionally removed to clear it of chips. It is best to stop the machine when doing this, to avoid the danger of getting the drill cramped between holder *J* and the hole in the work.

Note.—If the hole in the casting is of considerable diameter, say 2 inches or more, it should be cored out to within ¼ to ⅜ inch of the finished diameter, in which case a three-lipped chucking drill should be used instead of the flat drill. It will make the hole smoother, and avoid the tendency of the flat drill to chatter. It is often well, when using a flat drill, to bore a small directing hole, say one-fourth the diameter of the finished hole, for the flat drill to follow. This directs the point of the flat drill, and makes the pressure required for feeding very much less, as well. For cleaning the chips from deep holes, it will be found convenient to use a piece of ⅛ by ½-inch iron or steel, bent at right angles at a point ¼ inch from the end.

SHOP OPERATION SHEET NO. 18.

Oscar E. Perrigo. MACHINERY, October, 1907.



To Ream a Drilled Piece Held in a Chuck and Supported by a Center-rest.

1. With the work properly mounted in chuck and center-rest, clamp tail-stock *F* in the position shown, ready for the reamer. The work is supposed to have been drilled ready for this operation.
2. Select a reamer *K*, of the proper diameter for the finished hole. Place it in position as shown, with the center hole in its shank on the dead center of the lathe, and with the slightly tapered end of its cutting edges in the drilled hole in the work. Select a wrench or holder *J* that will fit the squared end of the reamer, and place it in position as shown.
3. Start up the lathe slowly, and proceed to ream the hole, holding the wrench *J* in the left hand to steady it, and at the same time feel the resistance which the material is offering to the cutting action. The reamer is carefully fed forward by the tail-stock hand-wheel, with the right hand. The reamer should be occasionally removed and wiped clean, to prevent clogging with chips and "roughing up" the hole.
4. When the reamer has been fed to depth, remove it, clean out the hole, and test it for diameter with a plug gage or inside caliper, to see that it is of the required diameter.

Note.—If there is a tendency to bind or "squeak" when starting a reamer, we know that the cutting edges are dull. If we are using an ordinary solid reamer, it will be proper to "stone up" the cutting edges, using the oilstone very slightly on the tops of the teeth, and more on the front of each cutting edge. If the reamer is of the expansion type, the blades should be carefully set out, and the cutting edges accurately ground to the proper diameter in a good grinding machine made for the purpose. This is ordinarily done in the tool-room.

OPERATIONS IN MANUFACTURING SMITH'S ADJUSTABLE REAMER.

The "one-lock" adjustable reamer shown in Figs. 1 and 2 is manufactured by the Wm. J. Smith Co. of New Haven, Conn. The accompanying half-tones illustrate operations followed in its manufacture. In Fig. 2, *A* is the body of the reamer;

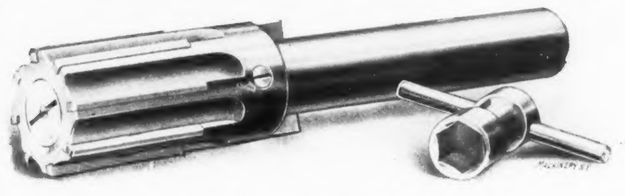


Fig. 1. The "One-lock" Reamer Assembled.

B, the shank; *C*, the driving key; *D*, a screw, loosely fitting a hole in *A*, for holding the parts together; *E*, the blades; *F*, a cam bolt, performing the two functions of adjusting the blades and locking them in place; *G*, the locking nut; and *H*, a wrench used with it.

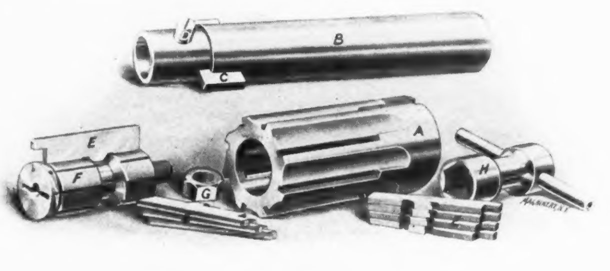


Fig. 2. Details of the "One-lock" Reamer.

Fig. 3 shows the method of holding the stock from which the reamer shell or body is made, for the first operation, that of boring. The work is held at three points, being tightened in place by adjusting the two set screws which back one of the contact strips. The tool on the left is a boring head, fitted with detachable high-speed cutting blades.

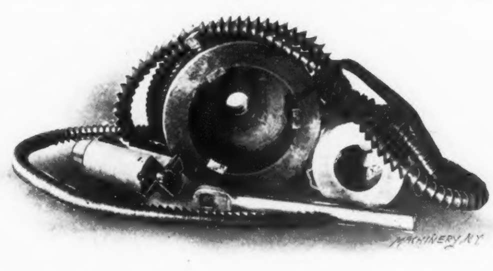


Fig. 3. Three-bearing Chuck, Boring Head, Work, and Chip Produced.

These, it will be seen, are set in the head in such a way as to give a sharp cutting angle. The work shown at the left of the cut has a small hole drilled through it previous to the boring operation. The chip shown is produced by the boring tool.

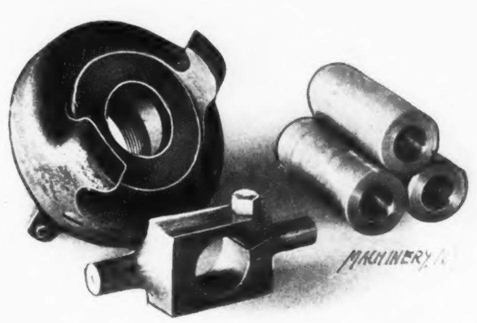


Fig. 4. Special Holder and Two-tailed Driver for Boring in the Turret Lathe.

For boring the other end of the reamer shell, a carrier is used for holding the work in the turret lathe. This carrier, shown in Fig. 4, screws onto the nose of the spindle. It is provided with locking wings which engage the two-tailed dog shown in the foreground. This construction equalizes the strain on the reamer shells, thus preventing cramping, and insuring the alignment of the holes bored from either end.

Fig. 5 shows a special device for graduating the end of the reamer shells. The shell is mounted on a taper split bushing, by which it is clamped to the index plate of the device. This index plate is operated by a ratchet, which accurately spaces the work for the required graduations. On the top of the frame is mounted a cross bar carrying a slide, with a cutter for marking the graduations provided for by

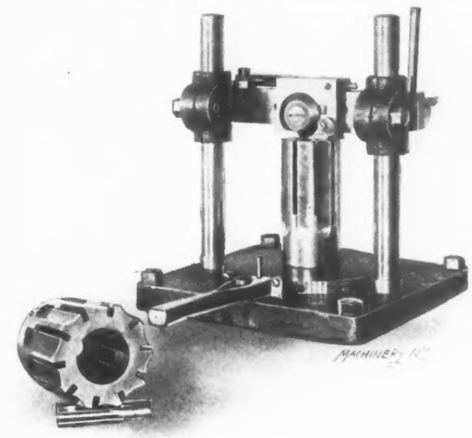


Fig. 5. Fixture for Graduating on the End of Reamer Bodies.

the index plate. The travel of this head is effected by a lever, and the movement is limited by an adjustable stop, varying in position for different cuts, so as to regulate the length of the graduations.

In Fig. 6 is shown the operation of milling the cam surfaces on the cam bolt. As shown, this is held between index centers in the milling machine, and shaped by a form cutter of small diameter. A smaller cam bolt with its cutter is shown on the table of the machine.

For machining the undercut by which the blades engage the cam bolt, the peculiar cutter, shown in Fig. 7, is used. This cutter, which reproduces the outline of the undercut on the cam bolt, has its cutting edge on the interior face. As shown, the work is set up in a hand milling machine.

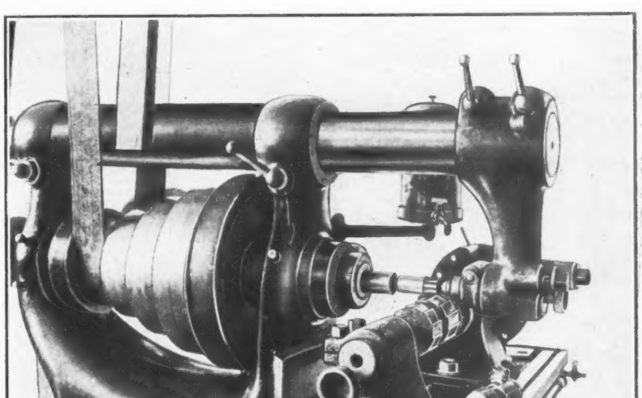


Fig. 6. Milling the Cam Surface on the Cam Bolt.

Fig. 8 shows a fixture used for holding the blades when grinding them. The blades are held in this fixture by the same means as provided for them in the reamer, the same cam bolt being used to engage projections at the bottom of the blades, which are set in slots in a cylindrical shell. These slots, however, are set at a slight angle with the radial position of the blades in the reamer, so that when the fixture with its blades is placed in the grinding machine and finished to a cylindrical surface, the tops of the blades, when replaced in the reamer, will clear the surface of the hole which they ream. This form of cutting surface is much superior to the flat shape given by the ordinary cutter and reamer grinder.

The shank of the reamer is slotted clear through for the

key by which the shell is driven. This operation is performed on the ingenious oscillating miller, built by the Hendey Machine Co., described in the April, 1905, issue of MACHINERY.

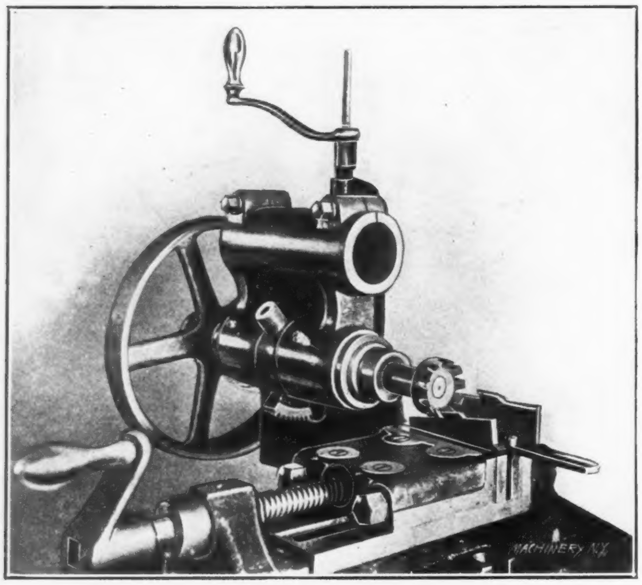


Fig. 7. Milling the Locking Undercut in the Blades.

The operation is shown in Fig. 9. The cutter has fine teeth, forming only a portion of a circle, and is held by a dove-tail in an oscillating bar, operated by an eccentric movement

Fig. 8. Special Arbor or Fixture for Sharpening and Grinding Relief on the Blades.

from the spindle. This arrangement is capable of working a rectangular slot clear through a bar in one operation, provided the teeth are kept clear of chips. In the case shown,

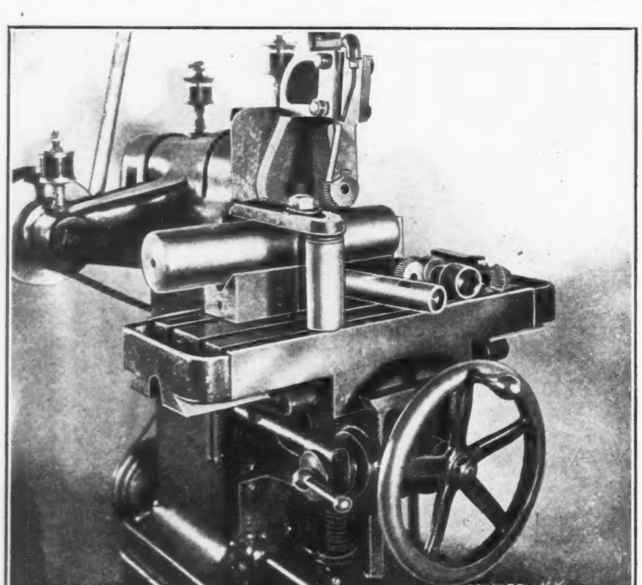


Fig. 9. Cutting a Slot with the Oscillating Milling Machine.

however, the slot is first roughly drilled to shape, and then finished by the oscillating process. The rectangular outline is obtained by this means at one cut.

A DRAFTSMAN'S TOOL CHEST.

I. G. BAYLEY.*

It is no unusual sight to see a draftsman carrying his tools tied up in a sheet of wrapping paper or even newspaper, while other craftsmen such as pattermakers or machinists, for instance, invariably carry their belongings in some kind of a box or case, though their tools are by no means so delicate or in need of so much protection as the draftsman's. The tool chest here described need not necessarily be a standard for size, shape or design; it can be changed to suit each individual taste or whim.

On account of its lightness and the ease with which it can be worked, poplar was chosen to make the box and nest of drawers complete, though it would be better, perhaps, if

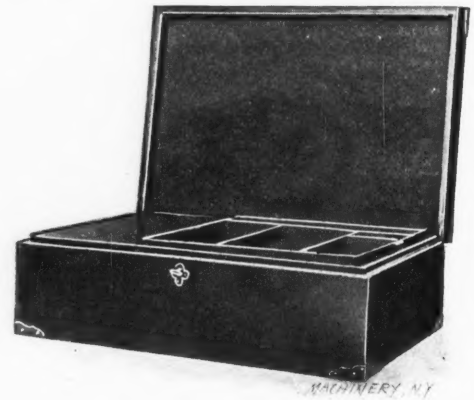


Fig. 1. The Draitsman's Tool Chest Finished.

the box were made of oak or other hard wood, and the nest of drawers and tray of poplar. It may be said, by the way, that the writer made the two latter with no other tools than a penknife and small iron plane; the chest or box was made by a cabinetmaker. Lepage's glue and fine nails were used to join the parts together; brass screws were used for the corner pieces, hinges and the name-plate. These trimmings may be either of brass or nickel. If poplar is used for the box, a mahogany finish outside, and shellac inside would look well, but a dull mission finish would be more serviceable if the box is made of oak.

It is sometimes convenient to have a secret drawer for money, stamps, etc., so one is here shown, though by the time the readers of MACHINERY have read this article it will

Fig. 2. The Tool Chest and its Contents.

be secret no longer. However, the suggestion can be altered or an entirely new design made.

The finished size of the box is 12 x 18 x 6 inches deep, outside dimensions. The box was nailed together, top, bottom, and sides, and then the top of lid neatly cut, one and a half inches down, with a fine saw, following a pencil line accurately drawn all around the box. On account of this saw-cut, the sides are ordered one-eighth of an inch deeper, as noted in the list of material. The bottom was let in, as it were, the sides being nailed around it. The top was made to cover over all. The sides were mitered so as to bring the joints exactly at the corners. After the lid was cut off, the edges were planed and sandpapered down to correct

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dimensions. A strip of wood is nailed part way around the box, one-eighth of an inch from the top, to keep out the dust and help in binding the lid when closed.

The nest of drawers at one end of the box is built up flush with the top of this strip of wood, so that the strips stop where the drawers occur, as shown in Fig. 2. The top, bottom and sides of the box are made of half-inch material. The strip of wood around the top is one-eighth inch thick.

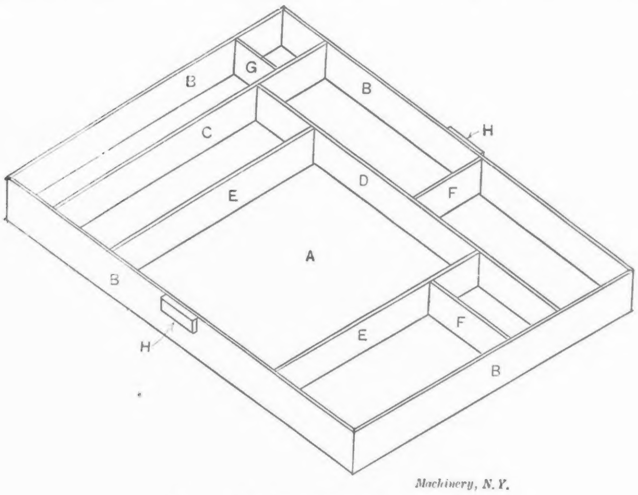

Fig. 3. The Tray for the Tool Chest.

The tray and the nest of drawers were made of one-eighth inch material, except the front of each drawer, which is one-quarter inch to give depth for securing the handles. There are three small drawers and one long one, the latter being for the instruments. The instruments were laid in the drawer in correct position, and blocks of wood, cut to suit, put between. The drawer was then covered with velvet, after the instruments had been removed and the whole given a coat of glue. The other drawers can be divisioned off or not to accommodate the smaller tools described in the list. At the front end of the nest of drawers a recess was made to accommodate the scales, these being a foot or more in length. The large triangles were put in the recess of the lid, the smaller ones kept in the body of the box or in the drawers. At the rear end of the nest of drawers is shown a small cupboard for the inkstand, a block of wood with three holes sunk in, to take as many small Higgin's ink bottles, black, red, and blue.

The secret drawer can also be put in this end, as shown in Fig. 4. This drawer can be omitted if desired and the false front of the small top drawer corrected to take its place. An elastic band holds the door shown, and also keeps the inkstand in place. The holes in the inkstand are three-quarters of an inch deep and one inch and three-quarters in diameter, and they must stagger with each other as shown or there will be difficulty in boring them. The tray, Fig. 3, fits the body of the box and is kept from falling in by the lugs at either end. The longest narrow space is for the penholders; the small space for the pens. The large space in the center is for the instruments. The pencils are kept in the space between this and the one for the penholders; on the other side of the large space is one made the same size as the inkstand; next to it is a smaller space for the tacks, pins, etc., the two remaining divisions being for the rubbers and pencil stubs, respectively. The idea is to fill the tray with the necessary tools, etc., when working, and placing it near the board or table for convenience.

Referring to the half-tones and line-cuts herewith, Fig. 1 shows the box open with the tray in position when not in service; Fig. 2 shows the box open, with the tray to one side to allow the drawers and cupboard to be seen. The inkstand is shown in the tray, and the tools, books, etc., are shown surrounding the box; Fig. 3 shows the tray with the various parts of which it is made, plainly marked, to agree with the bill of material; and, finally, Fig. 4 shows the nest for the drawers, with the latter as well as the cupboard door and the top of the nest removed. The pieces are marked to agree with the bill of material which follows. It would be well to cut all the material first.

Chest or Box. (Figs. 1 and 2.)

1.—Piece 12" x ½" x 18", top.
1.—Piece 11" x ½" x 17", bottom.
2.—Piece 6⅛" x ½" x 18", front and back.
2.—Piece 6⅛" x ½" x 12", sides.
3.—Strips ¾" x ⅛" x 11" (mitre joints).

Tray. (Fig. 3.)

1.—Piece 10⅜" x ⅛" x 10⅜", bottom *A*.
4.—Piece ⅞" x ⅛" x 10⅝", sides *B*.
1.—Piece ¾" x ⅛" x 10⅜", partition *C*.
1.—Piece ¾" x ⅛" x 9", partition *D*.
2.—Piece ¾" x ⅛" x 7¾", partition *E*.
2.—Piece ¾" x ⅛" x 2½", partition *F*.
1.—Piece ¾" x ⅛" x 1¼", partition *G*.
2.—Piece ⅜' x 3/16" x 1", lugs *H*.

Nest for Drawers. (Fig. 4.)

1.—Piece 6⅛" x ⅛" x 11", top *A* (not shown).
1.—Piece 4" x ⅛" x 11", back *B*.
2.—Piece 4" x ⅛" x 6", sides *C*.
(One side to be cut as shown, if secret drawer is used, otherwise both sides will be alike.)
1.—Piece 2½" x ⅛" x 6", side *D*.
1.—Piece 1½" x ⅛" x 6", partition *E*.
1.—Piece 1⅛" x ⅛" x 6", partition *F*.
4.—Piece ⅜" x ⅛" x 8", partition *G*.
2.—Piece ⅜" x ⅛" x 5¼", partition *H*.
6.—Piece ⅜" x ⅛" x 5¼", guides *I*.
1.—Piece 1" x ⅛" x 5¼", guides *J*.
1.—Piece 2⅝" x ⅛" x 4", cupboard door *K*. (Not shown.)
1.—Piece 2⅝" x ⅛" x 5⅞", bottom of cupboard *L*.
2.—Piece, ⅛" x ⅛" x ½", lugs for cupboard door *M*.
1.—Piece 1⅛" x ¼" x 2⅝" front of drawer *N*.
1.—Piece ½" x ⅛" x 1", stop for secret drawer *O*.

The front of false drawer (*N*) must be well secured to allow for the pulling it will get. If no secret drawer is used, the false front must be changed, a regular drawer taking its place.

Drawers.

1.—Piece 1⅛" x ¼" x 8", front long drawer.
1.—Piece 1" x ⅛" x 7¾", back long drawer.
2.—Piece 1" x ⅛" x 5¾", sides long drawer.
1.—Piece 5¾" x ⅛" x 8", bottom long drawer.
1.—Piece 1⅛" x ¼" x 5¼", front top drawer.
1.—Piece 1" x ⅛" x 5", back top drawer.
2.—Piece 1" x ⅛" x 5¾", sides top drawer.
1.—Piece 5¼" x ⅛" x 5¾", bottom top drawer.
1.—Piece 1⅜" x ¼" x 5¼", front bottom drawer.
1.—Piece 1¼" x ⅛" x 5", back bottom drawer.
2.—Piece 1¼" x ⅛" x 5¾", side bottom drawer.
1.—Piece 5¼" x ⅛" x 5¾", bottom drawer.
1.—Piece 1⅛" x ¼" x 5⅝", front secret drawer.
1.—Piece 1" x ⅛" x 5⅜", back secret drawer.
2.—Piece 1" x ⅛" x 2", side secret drawer.
1.—Piece 2⅛" x ⅛" x 5⅝", bottom secret drawer.

Ink Stand.

1.—Piece 2½" x 1" x 5⅞".

Ink stand to have three holes for bottles. Stand to be sandpapered and varnished black. The drawers are furnished with handles as shown; of necessity they must be small, and if flush with the front of the drawers, so much the better,

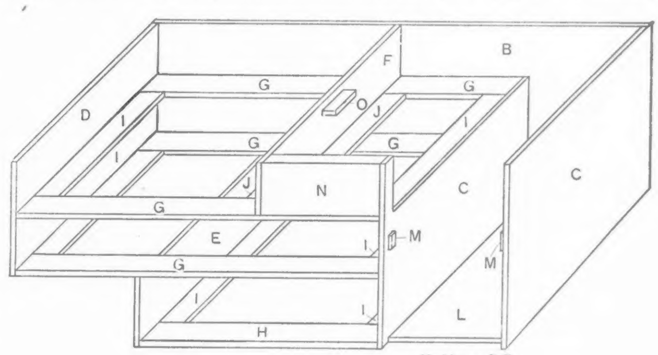

Fig. 4. The Nest for the Drawers.

in which case two lugs will be required to hold the tray up from falling into the body of the box; otherwise one end can rest upon the handles as in the case in hand.

The box can be carried by means of a strap when packed for shipping, or when moving from place to place.

A list of the tools, books, etc., contained in the box is given below.

5½". compass, pen, pencil, and lengthening-bar.
5½" hair-spring divider.
5½" plain divider.
3½" compass, pen and pencil legs.
2½" spring-bow instruments, pen, pencil and divider.

5" ruling pen.
4½" ruling pen.
Proportional dividers.
Small size beam-compass fixed needle-point leg, with pen and pencil legs, micrometer adjustment.
6" protractor, nickel-plated lead case.
Two triangular scales.
Trautwine's, Kent's, and Carnegie's handbooks, Data sheets from MACHINERY.
Instep's tables, sketch and note-books.
Four triangles, large and small, 45 and 60 degrees.
Pentagraph, 2 irregular curves, slide rule.
Three bottles Higgins' ink, black, red, and blue.
Three penholders, assorted pens, penwiper or rag.
Ink eraser, shield, scratcher, soapstone.
Pencils, HB, H, HH, HHH, HHHH, HHHHHH, pencil stubs.
Stub-holder, copying pencil, red and blue pencils.
Sponge rubber, or art-gum, several rubbers.
Tack-hammer, tack-lifter, package of 1-ounce tacks.
One dozen thumb-tacks, paper fasteners, clips, and pins.
6' folding rule, tape measure, calipers, knife.
Oil-stone, oil-can, file, dust brush, pencil sharpener.
Crayons, paint brush, paint box, pallet, magnifying glass.
Sheet horn for centers, fine needles.
Rubber bands (assorted), adhesive tape, pot of paste.
Pair of shears, string, gummed labels, tags, sealing wax.
Fountain pen, writing pad, blotters, small calendar.
Writing paper, envelopes, postage stamps.

Address book and visiting cards, complete the list, with room to spare for needle, thread and a few buttons, if you are an old bachelor.

* * *

METHOD OF GRADUATING IN THE LATHE.

WM. C. FORCE.*

If we have, say, 80 teeth in the cone gear of the lathe, it becomes easy to index for any number by which 80 can be evenly divided, by placing a pawl in contact with the teeth of the gear and counting as many teeth as required for each graduation. Fig. 1 represents the lathe head with the pawl bracket clamped to the bed, and the pawl in such a position

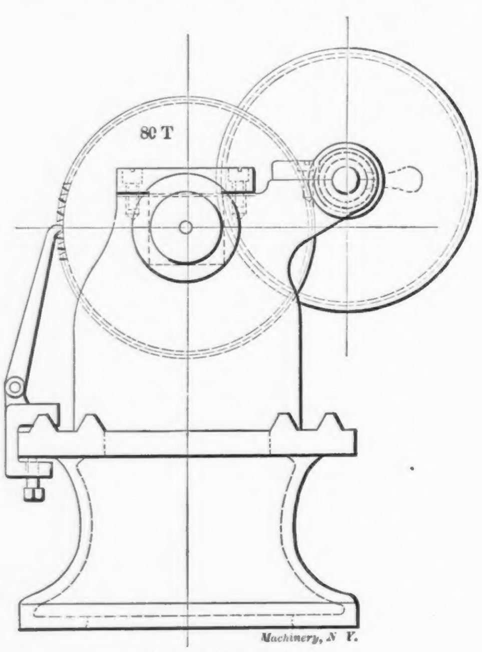

Fig. 1. Direct Indexing.

that when the gear is pulled forward, the pawl becomes locked between the teeth. The work to be graduated may be placed on the centers, in the chuck or on the face-plate, as circumstances will permit. Supposing, for instance, you desired to lay out a cast iron collar, dividing the circumference into four equal parts. You place the collar on an arbor, put a driving dog on in the regular way, and place the graduating tool in the tool-post, setting the point of the tool about at the same height as the lathe centers. The first thing to do after this is to find out the number of teeth to index, to obtain the four divisions on the collar. Divide the number of teeth in cone gear, assumed to be 80 in our case, by the number of divisions, 4, and we obtain 20 as a quotient, which is the required number of teeth to index on the cone gear. If we have a number of pieces to graduate in this way, it is well to place a chalk mark at each division on the cone gear so that it will not be necessary to count the teeth for each indexing. A cone gear with 80 teeth may be utilized with this method to obtain the following divisions, *viz.*, 2, 4, 5, 8, 10, 16, 20, and 40. If one wishes to graduate long and short lines on the work, it will be necessary to clamp a parallel to the bed of the lathe, using this parallel as a stop for the carriage to go against for long lines and using a distance piece between the carriage and the parallel for short lines.

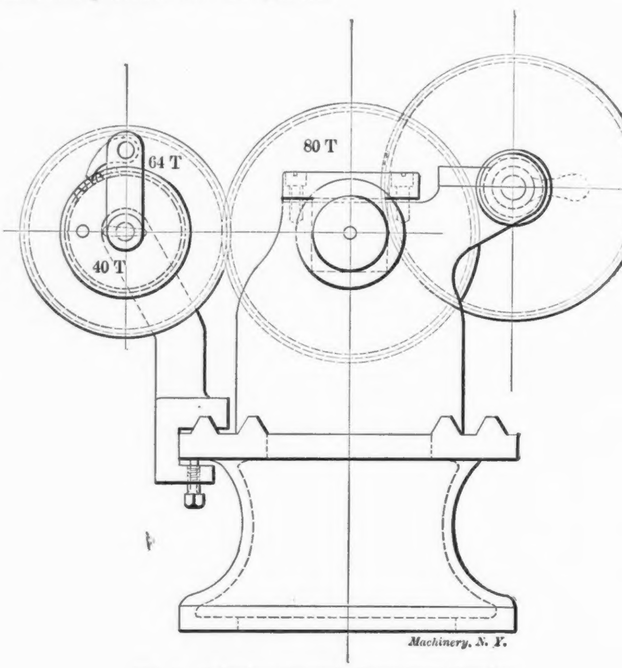

Fig. 2. Indexing through Compound Gearing.

In graduating a dial which is to give measurements of one-thousandth inch, when used with measuring screws having 20 threads and 40 threads per inch, it will be necessary to proceed as shown in Fig. 2. In the first place we will find that the number of thousandths of an inch in 1/20-inch equals 50, and the number of thousandths of an inch in 1/40-inch equals 25. As will be seen from cut, there are two gears keyed or pinned together and mounted on a bracket in such a manner as to be free to revolve on the stud in the bracket, one gear meshing with the cone gear. Fastened to the stud by a taper pin is the pawl-carrying bracket and pawl used to index the number of teeth on the index gear. It becomes a simple example in propo^rtion to find the gears necessary for 50 and 25 divisions. Taking 50 divisions for example, and assuming 64 as the number of teeth in the stud gear meshing with the cone gear, the proportion becomes $x : 64 = 50 : 80$,

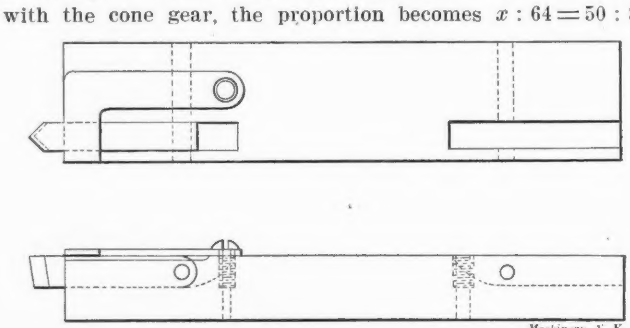

Fig. 3. Graduating Tool.

x being the number of teeth in the index gear. From this we find the number of teeth in the index gear to be 40. By indexing one tooth on the indexing gear we obtain 50 divisions, and by indexing two teeth we obtain 25 divisions. If we desire any other divisions than this combination of gears will give, it will become necessary to figure out a new combination and use another stud and index gear.

In Fig. 3 is illustrated a graduating tool which will be found to give better satisfaction than an ordinary sharp-pointed tool. As will be seen from the cut, it is a spring tool, relieving the tool on the back stroke, thereby preserving the point. It can be used either right or left hand, as the holder has a groove in one side on each end.

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LETTERS UPON PRACTICAL SUBJECTS.

SECTIONAL SUB-PRESS DIE.

In the May issue of MACHINERY appeared a description of a sectional punch and die by A. C. L. There is no doubt that such a die could be simplified by making it on the sub-press principle. Every detail seems to have had attention and everything seems to have been done, except the one fundamental and essential thing necessary for rapid production of accurate work.

In the cuts herewith are shown dies and punches for sub-press work, which may be of interest to the readers of MACHINERY. In the assembled view, Fig. 1, the die is shown.

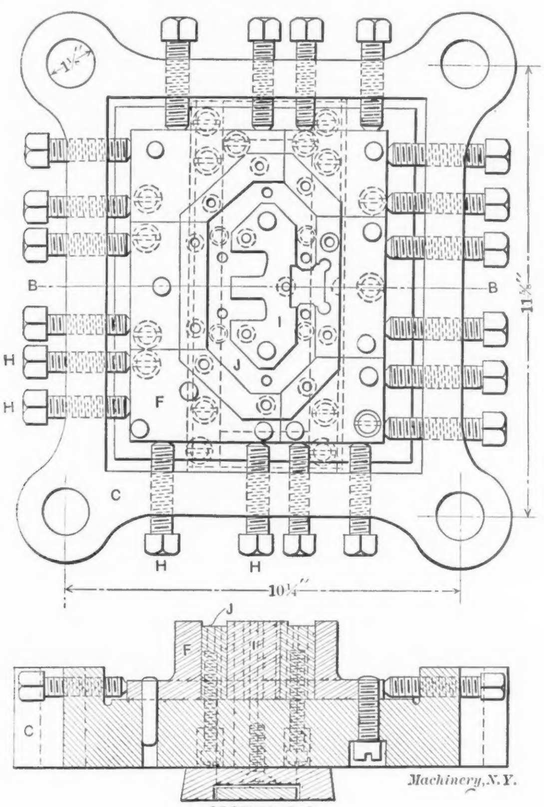


Fig. 1. Sub-press Die

It will be seen that the blanks can be changed to different shapes by simply inserting different die sections in different places of the die. At *A*, Fig. 3, is shown a modification of the blank, possible with this die. Another of the principal features of the sub-press sectional die is the means for stripping the scrap and ejecting, when it is wanted to produce punchings in quantities. The die shown in the cut may appear to be unduly light in construction, but several sets have been built on these lines, and given full satisfaction. Their light weight materially lessens the cost of handling, as well as the cost of making. The holder *C* is of good, close grain cast iron, planed on both sides. At the top, a recess is milled with an end mill in a vertical miller. In this recess are held the sectional parts of the die, which are fastened to the body from the bottom. After having made the necessary templets, the various die sections are shaped. A few thousandths of an inch is left on the adjoining surfaces to permit finishing by grinding. The cutting edge of the die sections must be left as hard as possible. Die section *F* is shown in detail in Fig. 3. It will be noticed that two small holes are drilled in the center of the two screw holes in the piece *F*. This is done to enable transferring the screw holes to the cast iron holder when assembling the die. The bottoms of the die sections are left soft in order to be able to drill all the screw and pin holes through the cast iron holder at the same setting. The dove-tailed slot in the holder *F* is made for the purpose of marking the punching. Each section is reinforced on the two outer sides by four set screws *H*. In the center of the die a solid block *I* is fastened with three screws and two dowel pins. This block is hardened and ground all over to the shape of the templet. The ejecting or stripping device *J* for the die is made of a solid tool steel piece to the same shape as the templet, but is a very free fit, amounting to a few thousandths of an inch on the sides. This part is left soft and is located a few thousandths inch more than the thickness of the punching below the top of the die. When the die is sharpened, the stripper is ground off the same amount. No springs are used with the stripper, it being actuated by two 1-inch studs fastened with screws on the stripper. These studs pass through the die and holder, and are actuated by a bar fastened to the gate of the press, thereby forcing out the punchings from the die. The six punches *N*, Fig. 3, are upset, as shown, at the end where they are inserted in the holder, while the other end is hardened, straightened, and lapped to size. The holes for the punches are located after the die is finished and assembled.

The cast iron punch holder *K*, shown in Fig. 2, is planed on top and bottom and across the four bosses. The four sub-press pins *D* are of tool steel, hardened as far as the head, ground to a light driving fit on the head end, and ground to a sliding fit in the die holder on the other end. The holes for these pins were located so that they are strictly in line with each other, and at the same time square with the punch and die. When the punch and die parts were hardened, they were placed together with two parallels placed between the castings, the punch placed inside the die,

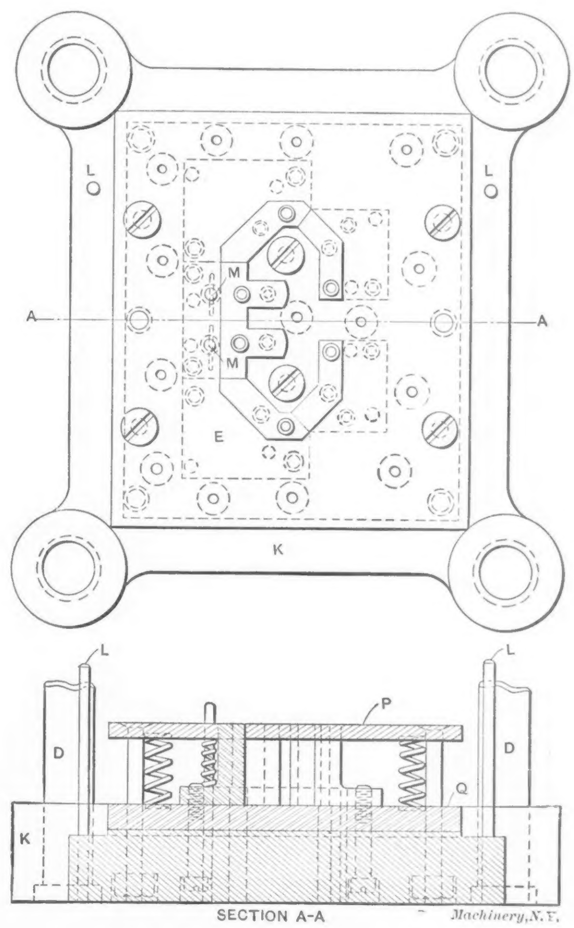


Fig. 2. Punch for Sub-press Die in Fig. 1.

and the two clamped together with four C-clamps. In this way the holes, when bored, were bound to come in alignment.

The punch part which is shown at *E*, Fig. 3, is made precisely as the corresponding die section, only that in locating the positions for the piercing bushings *O*, it sometimes happens that the holes for the bushings are so many and so small that they cannot be conveniently bored. The holes are then transferred by a drill that runs through the die, and are of the same size as the piercing plug, the die being used as a drill jig. After drilling, the holes are counterbored to

the right size for driving fit for the bushings. The latter are hardened and ground all over, and the holes in them taper one-half degree. A straight pin, driven in so as to be located halfway in the bushing, and halfway in the section E, holds the bushing in position while in operation. A stripper plate P is placed over the punch sections with a free fit on both inside and outside. It is held by flat head screws which are adjusted with nuts from the bottom of the holder.

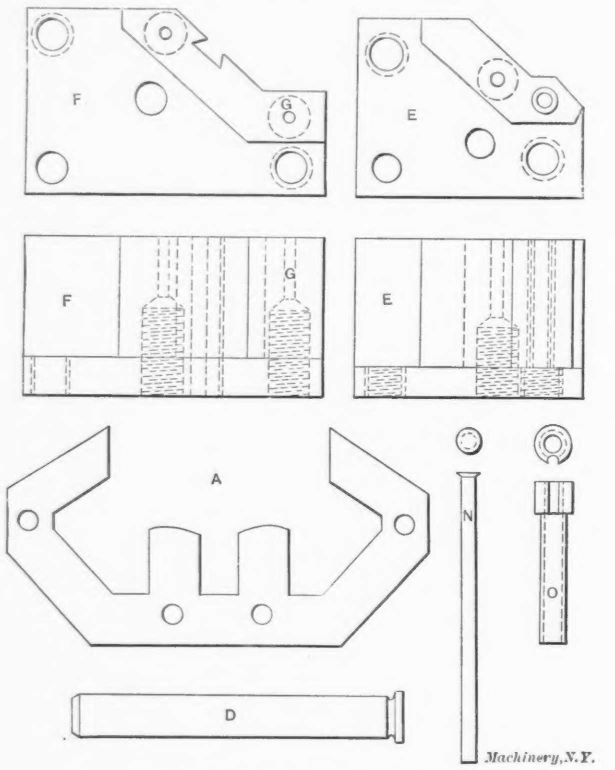


Fig. 3. Details of Sub-press Die.

Between the stripper and the punch-shoe Q, which is made of tool steel and hardened, sixteen spiral springs are placed to strip the metal. The punch-shoes themselves are secured with six screws to the cast iron holder K.

Two guide pins L, Fig. 2, are driven into the top of the cast iron holder K, and two gage pins M are located 1/16 inch from the cutting edge. A small wire is driven through the gage pins, below the stripper, having a spiral spring underneath, seated on the punch-shoe. When the die comes down, forcing down the stripper plate, the gage pins follow, coming up again on the upward stroke.

L. A. Dorman.

ADDITION AND SUBTRACTION ON THE SLIDE RULE.

It seems to be generally supposed that it is impossible to perform addition and subtraction on the slide rule. This, however, is not so, as it is really a simple matter, and a little practice will enable anyone familiar with the slide rule to perform both operations with speed and accuracy.

Rule for addition: Assume that the scales are numbered in the usual manner, A, B, C, and D, commencing at the top of the rule. If we now wish to add 372 and 284, set the glass indicator to 284 on the D scale, and move the slide until 372 on the C scale coincides with 284 on the D scale and read the quotient 1.31 on the C scale. Add 1 to 1.31, making the sum of 2.31, and multiply 284 by 2.31, the product being 656. Then check the right-hand figure in the sum by adding mentally the right-hand digit on each number, thus, $4 + 2 = 6$. The answer must then be 656, since we read it to be between 650 and 660. The decimal point in the first operation is located in the same manner as in ordinary slide rule operations. That the rule for addition on the slide rule, as given above, is correct is proven in the following manner. Suppose that E represents the larger number; F, the smaller; and G, the quotient of E divided by F. Then

$$\frac{E}{F} = G, \text{ and consequently } E = FG. \qquad (1)$$

In this equation add F to both sides. Thus

$$E + F = FG + F = F(G + 1) \qquad (2)$$

If in this equation we substitute the numbers 372 and 284 given in our example, we have

$$372 + 284 = 284\ (1.31 + 1)$$

which, we see, agrees with the operations as we performed them.

Of course the figure 1.31 is not exact, but it is near enough to obtain the first two figures exact, and the third figure is obtained exact as has been explained before.

Rule for subtraction: Suppose that we want to subtract 284 from 372. Set the glass indicator to 284 on the D scale, and slide the runner until 372 on the C scale coincides with 284 on the D scale, which leaves the quotient 1.31 the same as in the case of addition. Subtract 1 from 1.31, leaving 0.31, and multiply 284 by $0.31 = 88$, which is the desired remainder. This rule is proven in a manner similar to that for addition. Assume that K is the larger number, and L, the smaller; then

$$\frac{K}{L} = M \text{ and consequently } K = LM. \qquad (1)$$

Subtract L from both sides of equation 1 and we get

$$K - L = LM - L = L\ (M - 1). \qquad (2)$$

If we substitute the numbers which we used in our example in this equation we have:

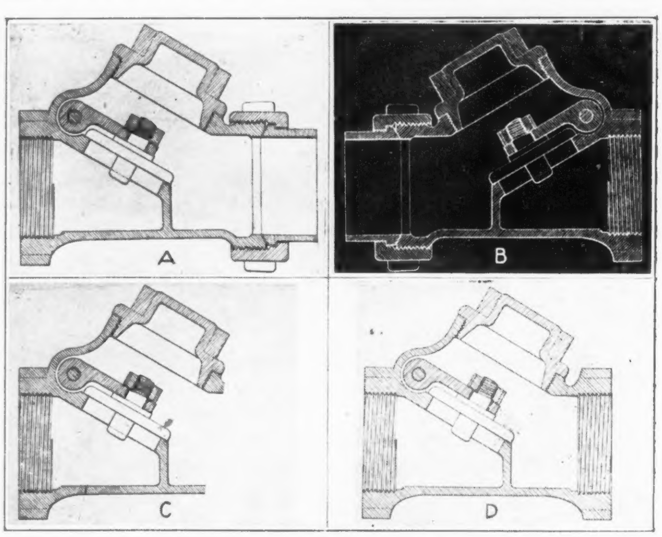
$$372 - 284 = 284\ (1.31 - 1) = 88.$$

Claremont, N. H. Wm. C. Michael.

[The method explained above, while it is interesting as a demonstration of the mathematical principles on which the slide rule is founded, as well as the close connection between all mathematical operations, seems of course of little value for any pratical purpose, because the time taken to perform addition or subtraction on the slide rule in the manner explained will be several times the time necessary to perform this operation in the ordinary manner by adding the digits.—Editor.]

CHANGING DRAWINGS QUICKLY.

Occasionally a big change in a drawing is necessary, and a print is wanted at once, or a different style of machine is to be made, having the major portion exactly the same as shown on some previous drawing. The accompanying cut illustrates this case. A rapid method for changing the drawing is as follows: A tracing shown at A is on hand, but we wish a print showing this valve with a female pipe thread on both ends. From this tracing we then make a



Method of Changing Drawings Quickly.

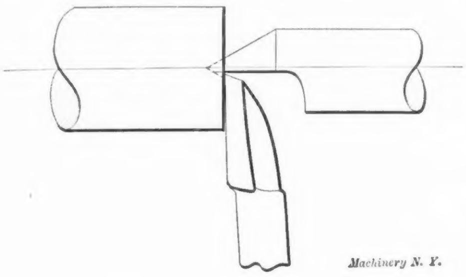
negative, shown at B, using a brown process paper. Now with a piece, or pieces, of brown opaque paper cover up all parts of this negative, B, that should not show on the required print. From this partially covered negative make a new print, C, again using brown process paper. On this new print, C, draw with india ink the special part of the new style valve and use the drawing D, thus obtained, as an ordinary tracing. The brown lines will print as well as the added lines in india ink. Howard D. Yoder.

Wadsworth, Ohio.

NOTES ON CENTERING.

The letter by W. S. Leonard in the August issue of MACHINERY brings up one of the most important points in good lathe work, namely, properly preparing work for turning. The writer worked seven years at the business in engine shops, having the reputation of doing good work, before he saw a center reamer or learned that 60 degrees was the proper angle for a lathe center, and there are hundreds of mechanics in the country to-day who put in centers with a 90-degree center punch.

In centering a piece of work, the first thing to be done is to file or grind the end straight, if it is a rough forging, or grind off the teat, if it has been cut off in a machine. Then, if you have a centering machine, the work can be centered in that; if not, locate the center with a pair of



Half-center and Facing Tool.

dividers and prick-punch it lightly. Then drill and form the center with the two-lipped combination center drill and reamer, first introduced by J. T. Slocomb Co., and now made by several concerns. With this tool the cut is balanced, and the drill part steadies the reamer, insuring that the clearance hole is true with the angle, and that the centers are reasonably round. If you have not the above, the small hole should be drilled for clearance and lubrication about two-fifths the diameter and about twice as deep as you want the center. The drill is followed with the center reamer, care being taken to make the latter cut concentric with the small hole. A half round reamer is better than the ordinary three-fluted one, as the centers cut by it are always round.

After centering, both ends of the piece should be faced off true, so that, as the center wears, it will wear evenly and not get out of true. Mr. Leonard will find that in using a tool sharpened as he describes the point will not stand up, and if he succeeds in getting out more than one piece without a ridge around the center, and without re-grinding the tool, he will accomplish a miracle. The best method is to use a half-center for the foot-block as shown in the cut. This center has nearly half of the taper point cut away, leaving but little over a half circle to support the work, so that the end can be faced clean. ALLAN.

THE POSITION OF THE CHECK NUT.

Mr. Oskar Kylin's article on the position of the check nut in the August issue of MACHINERY is very interesting and instructive from a theoretical point of view, but under practical conditions it is far better to have the lock nut placed on the top of the regular nut. The reason for this is because the average workman in erecting machinery tightens up the first nut as tight as he considers necessary, which is generally as tight as he can; he next puts on the second nut, which he makes fairly tight, and then passes on to other work. Do you suppose he would hunt up the special lock nut spanner and hold back the lock nuts? No, sir; he wants to get the job finished in good time and monkey business like that "don't go." I know from actual experience with erecting gangs.

Let us see what the effect of this treatment is upon the theoretically correct position of the lock nut. Suppose we have a bolt on which a total strain of 1,000 pounds will be developed when both nuts are tightened up. The lock nut is placed upon the bolt first, according to blue-print, and drawn down to 1,400 pounds strain to make everything tight; then the regular nut is placed on top, tightened up to about 400 pounds, and let go at that. These conditions cause the lock nut to carry 1,000 pounds load and the regular nut only a 400-pound load, which is about the worst condition imaginable. Now let us take the "incorrect" way. The regular nut is put on first, drawn down to the 1,400 pounds strain, then the lock nut is placed on and drawn down to the 400 pounds, and the workman passes on, leaving conditions which, next to a correctly placed and carefully adjusted lock nut, are a very satisfactory distribution of strains, and the regular nut is to all practical purposes thoroughly locked just the same, unless the bolt actually moves forward enough to lift the bottom nut out of contact with the base, which is a rare and special case.

Here then is a point where actual practice is directly contrary to theoretical considerations; but we are dealing with actual conditions and must design our machinery to give satisfaction and results with the average workman's treatment, and must make our average blue-print show the lock nuts on top. By doing this we are sure to get best results, for the general workman will throw the greatest strain on the strongest nut. On all my designing requiring lock nuts I invariably show two regular nuts. The difference in cost is very slight and is offset by the saving in the stock room and avoidance of mix-ups in shipping. I know then also that, no matter how the workman may juggle up the method of locking, a regular full strength nut will always carry the majority of the load. GEO. P. PEARCE.

Williamsport, Pa.

[That practice in the above case is directly contrary to theoretical considerations, as our correspondent contends, is perhaps a rather daring statement to make. Whenever theory and practice seem to disagree, either the theory is wrong, that is, it simply has to be disproved, or the common accepted practice is wrong, in spite of being accepted. In the case in question, if the upper nut is not tightened down so as to place a greater stress on the bolt than that placed on the bolt by the lower nut, then both nuts will bear against the same side of the threads of the bolt, and there will be no real locking action. The check nut in that case does not really act as a check nut at all, but rather as an increase in length to the one nut already in place. When a check nut actually fills its purpose of locking the lower nut in place, it must place a greater stress on the bolt than does the lower nut alone, that is, the two nuts must bear against different sides of the thread in the bolt. This is the condition Mr. Kylin analyses, and that being the practical condition desired, his theory agrees with it.—EDITOR.]

SPRING CHUCKS.

Spring chucks are deservedly popular. They are of numerous designs, some good, some poor. Perhaps the most frequently met with of the poor designs is shown in Fig. 1. This chuck is simple enough, being composed of two parts only, the nut and the jaws or holder. The jaws are a part of the shank. In this case, however, simplicity does not

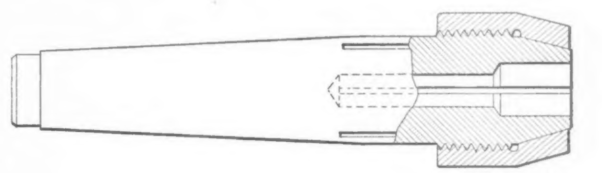


Fig. 1. Common, but objectionable, Form of Spring Chuck.

stand for accuracy. The fault with this chuck is evident. By turning the nut, the jaws close, but at the same time the threaded portion of the shank reduces in diameter, becomes a bad fit, and is imperfectly round. The nut thus can assume a faulty position on the thread. Still, where no great accuracy is essential this chuck will answer the purposes for work which does not vary much in diameter.

There are two good designs in common use. One is the draw-in chuck, as found on tool-makers' lathes, and the other the push-out chuck, as found on turret lathes. These are good design, because the taper into which the jaws are forced is a solid ring—usually fixed to the machine spindle.

Even these chucks are true for but one exact diameter, though in practice they work well when the stock is slightly off size.

Sometimes it is difficult to arrive at a correct design for a particular condition. Fig. 2 shows a special design which will probably find appreciation. This chuck is used in an automatic gear cutter. The pinion which it holds is very small in diameter compared with the shaft of which it forms a part. Consequently, there is little room for any kind of holding device. When the gear cutting machine is indexing, the cutter is in the position shown in Fig. 2. Hence the chuck which holds end *A* of the pinion must not extend beyond a certain line.

The general design of this chuck is as follows: The chuck has three spring jaws *J*, produced by slotting the body in three places, part way, leaving the end *S* solid. These jaws are fitted into the taper end of a chuck closer *T*, solid with

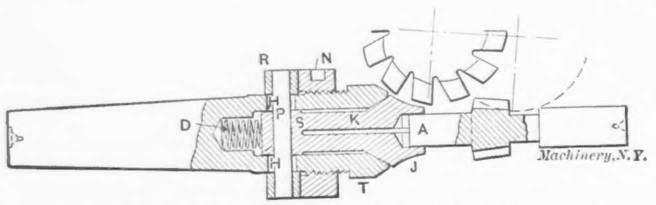


Fig. 2. A Special Spring Chuck for a Difficult Case.

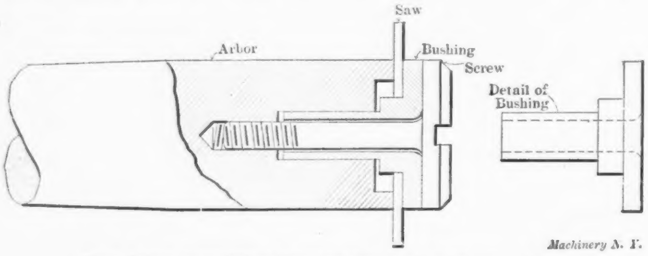
the shank. A nut *N* turns on the threaded portion of the closer or shank. This nut moves a ring *R* which is joined by a stiff pin *P* to the end *S* of the spring jaws. The pin *P* passes through slotted holes *H* in the shank. Hence if the nut is turned in the right direction it draws the spring jaws in on the taper and closes them.

In making this chuck certain points must be observed: The shank must be bored true with the taper; the spring jaws must fit perfectly on the taper, and at the end *S*; the nut must be faced true with the thread; and finally, the spring jaws should be heavy enough at *K* to resist the bending strain which is caused by the grip being beyond the taper, which closes the jaws. An auxiliary spring is shown at *D*. This can be used if it is found that the jaws fail to release when the nut is loosened. A chuck of this design, without the spring *D*, is in actual operation and gives perfect satisfaction. It fits the indexing spindle of the machine on which it is mounted. HARRY A. S. HOWARTH.

New Haven, Conn.

SAW ARBORS.

In reply to the inquiry by "Artebe" in the August issue of MACHINERY, in reference to the best type of saw arbor, would say that in my opinion none of the four arbors shown give the satisfaction and capacity for saws that is desired for gen-



Saw Arbor, permitting Greatest Interchangeability of Saws

eral work. No. 1 arbor will only hold saws of one bore and, rightly, only one thickness with one washer; it is also soft and will soon wear out of true. No. 2 has the same defects, except that the hardened bushing gives it much greater durability. No. 3 depends for its accuracy upon the concentricity of the plain portion of the screw with the thread, which is a poor design because of the difficulty of tapping with accuracy concentric with the hole; should the screw run eccentric, the result will be that the plain portion, or shoulder, will bind on one side of the hole and in a short time cut or wear the counterbored portion oval. No. 4 is also open to the same objections. I would advise the saw arbor shown in the accompanying cut as one that is fairly cheap to manufacture, and yet fills all the requirements satisfactorily. The hardened bushings which are comparatively cheap to manufacture can be changed to suit saws with various sized holes, and variations in thickness of saw require no changes at all. PENNSYLVANIA.

A BLACKSMITH'S DRILL JIG.

In the two accompanying half-tones and the line-cut is shown a special kind of drill jigs, specially designed for small parts which have to be produced in large quantities, and at the same time must be accurate. This jig I term a tong jig. It is forged, but it could be made of cast iron. If it is made out of cast iron, the handles should be made from small gas pipe, and either threaded or pinned to the jig. Making it from a forging, however, gives the advantage that the handles can be drawn down to a taper, giving to the jig the necessary elasticity for holding the work in place when the link *A*, Fig. 1, is slipped into place. This kind of a jig must be hinged at *B*. The lower and larger part *U* is machined for holding the pieces to be drilled, the top piece *D* containing the bushings. For castings or parts which are shaped to a circular segment this jig is very handy, as the

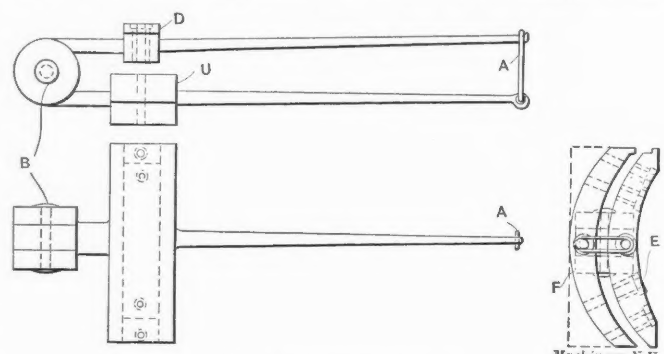


Fig. 1. A Blacksmith's Drill Jig.

operator can, by holding the handles, turn the jig to any angle desired. This jig requires no blocking up or clamping. The jig shown schematically in Fig. 1, is intended for work of a segment shape, but for straight work the bottom *F* should be straight, as indicated by the dotted line. The half-tones, Figs. 2 and 3, show another application of the

Fig. 2. The Jig Open, and the Work to be Drilled.

same principle in jig making. Fig. 2 shows the jig open, together with the piece to be drilled, before putting it in place. Fig. 3 shows the jig closed with a piece in place and the link over the handle. This jig differs from the one shown in Fig. 1 therein that the part holding the work to be drilled runs lengthwise of the handles. Of course, the various jigs will have to be made to accommodate the construction of the parts to be drilled. The angle casting for which the jigs in Figs. 2 and 3 is used is about 3½ inches long, with a small boss on the inside of the angle. Since this jig was put in use, not one part in a thousand has been scrapped.

As will be seen, this jig registers from the proper point, *viz.*, the outside corner, and if any chips are in the jig, the operator cannot put in another piece. Consequently he has to keep the jig free from chips and dirt in order to close the handles before drilling. The tool is very simple to operate. There is no bother with a number of screws and

clamps, two or three different sizes of wrenches, etc., as is usually the case with a box jig, which takes much longer to handle for putting in and taking out the pieces than it does to drill the holes. Another advantage with this tong jig is that, after the part that holds the work to be drilled has been properly machined, the operator cannot drill a piece until it is placed properly where it belongs, as he cannot

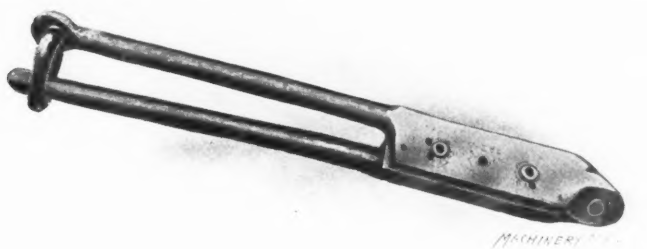


Fig. 3. Jig Closed, Ready to be Used.

close the handle. The writer has known of parts being put in box jigs, bottom side up, and the mistake has been discovered first when the holes have been drilled. Since the introduction of the first of these jigs in this shop, they have been coming rapidly to the front in this factory, and are driving the box jigs out of the business. J. F. SALLOWS.

Lansing, Mich.

CUTTING A SPECIAL CAM.

It often happens, even in well equipped shops, that odd jobs come up for which there are no tools, and which have to be produced in the old-fashioned way with the aid of common sense and a little rigging. Such was the case with the grooved cam, the form and development of which are shown in Fig. 1. It happened that in this case only the end positions of the roll were important, and all that was necessary with regard to the curved part of the path was a reasonably smooth action, the variation of the height of the roll due to the swinging of the lever on its fulcrum not being of enough importance to be taken into consideration.

We decided to cut it on a milling machine, and we first looked up a fixture, shown in Fig. 2, which had been used

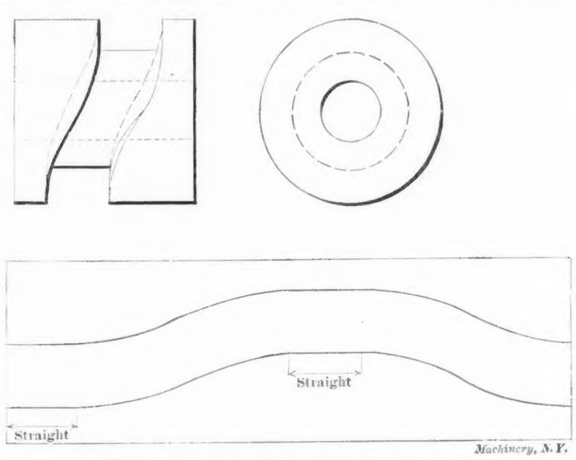


Fig. 1. Cam to be Cut, and its Development

some years before for a similar job, and by good luck had not been scrapped. As will be readily seen, this fixture has provision for clamping on the milling machine column, and a small adjustable slide at the top carrying a pin to follow the former. In addition we had to make the arbor and former, shown in Fig. 3. In making the former, a blank was first made; then the development of the cam was cut out as accurately as possible from a thin piece of tin and transferred to the former by wrapping the tin about it and scratching the outline. The former was then placed on an arbor in the milling machine, and an end mill of the same diameter as the roll was placed in the spindle, the center lines of the mill and roll being exactly in the same plane. The outline was now worked out as close as possible, feeding by hand. The last operation was to smooth up the curves with a file, and we were ready for making our cam.

The fixture was fitted on the milling machine column with the pin in the slide in the same horizontal plane as the spindle of the machine. The table screw was removed, and a rope was attached to the end of the table and run over a

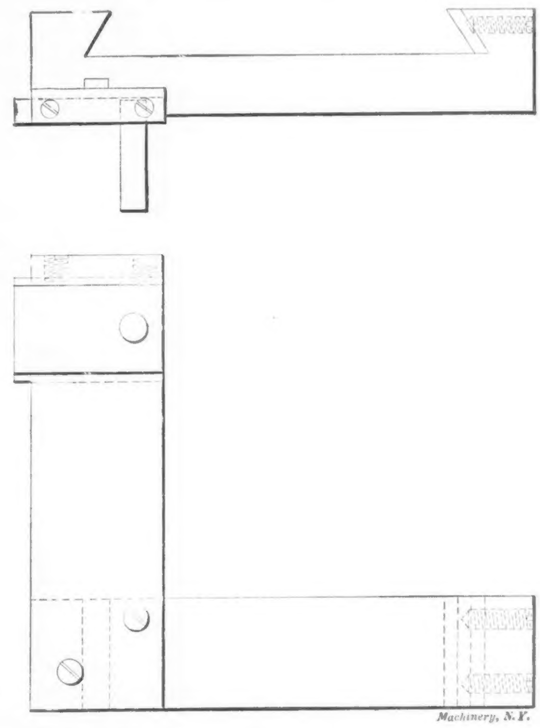


Fig. 2. Bracket to be secured to Milling Machine Column when Cutting Cam.

pulley in a wooden frame placed on the floor. A weight on the other end of the rope supplied the power necessary to hold the former against the pin. With the center line of the cam blank and former set at the same height as the axis of the milling machine spindle, and the blank and former assem-

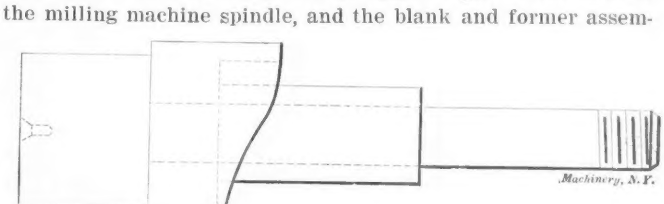


Fig. 3. Arbor and Former.

bled on an arbor, the arrangement was as shown in Fig. 4. The slide carrying the former-pin was adjusted to bring the end mill central with the position desired for the slot, and locked. On account of the spring in the parts, the slot was first roughed out, full depth, with a mill 1/16 inch under-size,

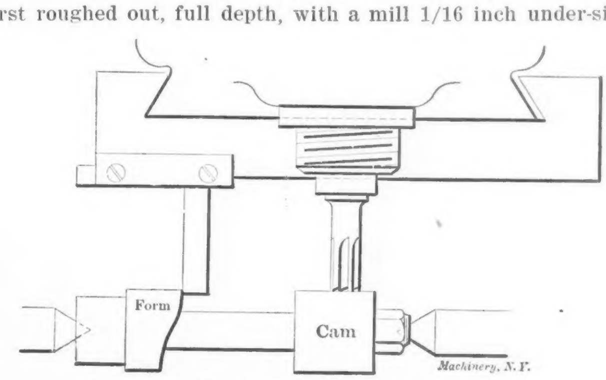


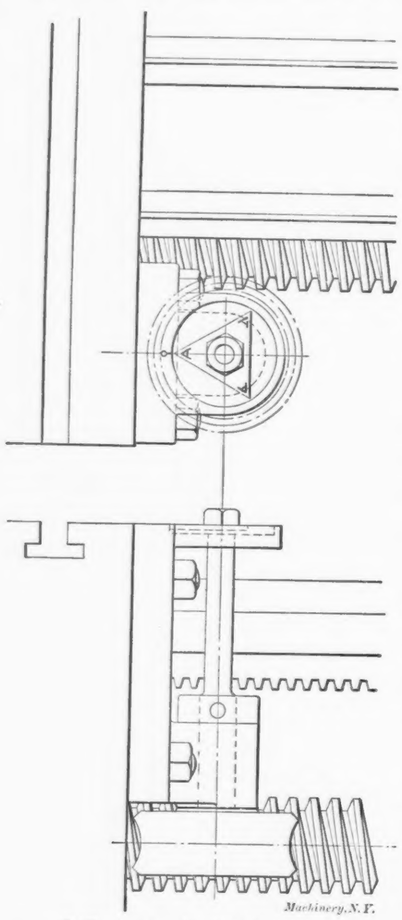
Fig. 4. The Machine as Fitted Up for Cutting Cam.

and afterwards finished with a mill the full size of the cam roll. The former-pin must be the same size as the finishing mill. The cams made in this way required very little fixing up in the curved part, and the straight portion came exactly as desired. ALLAN.

INDICATOR FOR THREAD CUTTING.

When cutting a thread in a lathe, if the number of threads to the inch being cut is a multiple of the number of threads to the inch on the lead-screw, the split nut may be

thrown into mesh with the lead-screw at any time, and the tool will follow the first cut. This is not the case, however, when the number of threads to the inch being cut is not a multiple of the number of threads to the inch on the lead-screw. Because of this, lathes are generally equipped with a backing belt, which is thrown in when the tool has made the desired cut, and the carriage is brought back to the starting point without having been disengaged from the lead-screw, which, of course, necessarily brings the tool into the right relation with the work. This is a good arrangement for short threads, say two or three inches in length, but when they are longer, and especially when they are large in diameter (which means slower speed) the backing belt is not a very economical contrivance, because considerable time is wasted while the carriage is being moved by the lead-screw from the end of the cut, back to the starting point. The accompanying illustration shows a simple device which may be attached to any lathe, and used to a good advantage when cutting threads. It can be fastened to the carriage as shown in the cut, and preferably on the side next to the tail-stock, as very often there is not enough thread on the lead-screw to permit its being put on the opposite side. This indicator is used in the following manner: Start the lathe, and when one of the three points marked *A* of the triangular pointer (see plan view), is opposite the zero mark, throw the split nut into mesh with the lead-screw. After the tool has reached the end of its cut, bring the carriage back by hand to the starting point. Wait until either of the points marked *A* is again opposite the zero mark, then throw the split nut into mesh with the lead-screw as before. If this is done with each successive cut, the tool will always come right with the thread. When the pointer is a triangle as shown, the worm-wheel, which is in mesh with the lead-screw, should be so proportioned that its number of teeth is three times the threads per inch of the lead-screw. If, for example the lead-screw has eight threads per inch, then the worm-wheel should have twenty-four teeth. Then, when either of the points marked *A* is opposite the zero mark, the lead-screw and the lathe spindle would occupy the same relative positions. The device does not work for fractional threads.



Indicator for Thread Cutting.

JOHN BRADFORD.

[This valuable device is not new, however. It is claimed to have been originated in this country thirty or thirty-five years ago by William Gleason, of Rochester, N. Y. In fact, however, it is much older than that, having, we believe, originally been invented in England. See MACHINERY, December, 1897, May, 1899, and February, 1901.—EDITOR.]

THE "MONEY-BACK" SYSTEM.

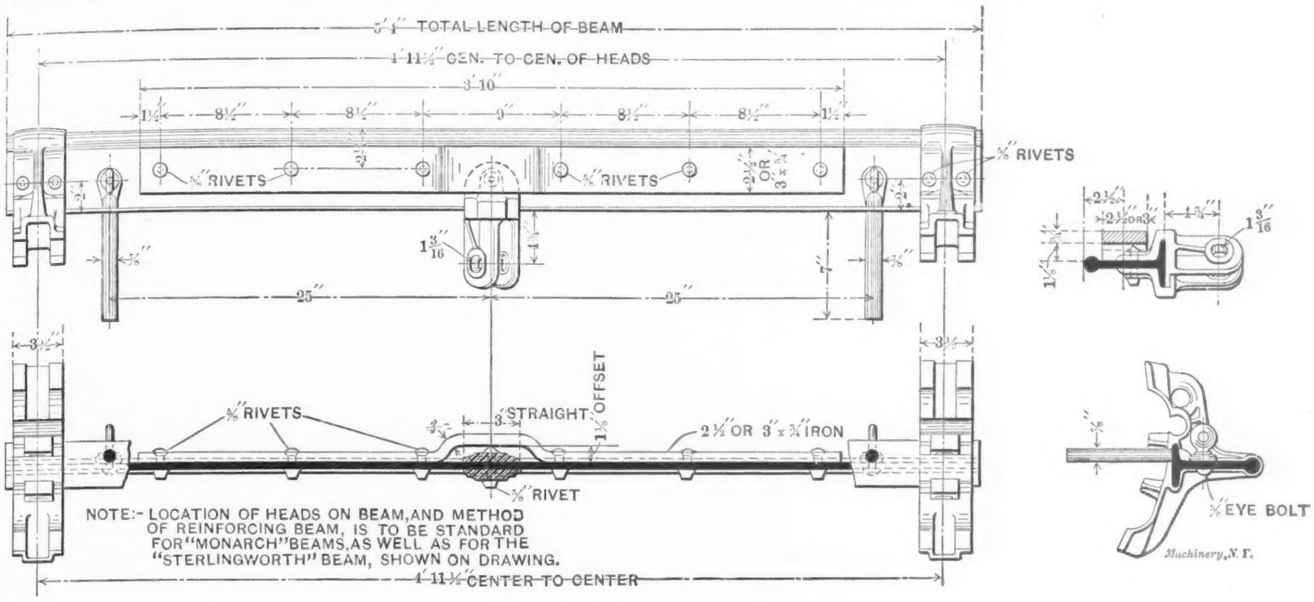
Lately we are seeing a good deal of what Elbert Hubbard calls the "money-back" system. This system simply means that if you don't like what you buy you can take it back and get your money back. Of course, you cannot really expect to use it a great while before you take it back; that is, you would not think you could, but a friend of mine had an experience that made him wonder where some people thought the limit was. He was asked to bid on two or three small machines of a slightly special character. He did so after finding out the requirements. He was asked if he would guarantee the machines to do the work, and he said he would, for in writing his bid he agreed to make the machines "satisfactory," in which he showed a laudable faith in his fellow men, and a lamentable absence of knowledge of law. The machines were delivered, certain defects were found in their working and certain improvements suggested and made, all of which was swallowed by the builder without comment.

About four months after the last alteration was made, the builder wrote and mentioned the fact that he could use some money to advantage, and would Mr. Purchaser kindly send a check? Mr. Purchaser did so for the full amount of the bill, and the builder forthwith spent the money and regarded the incident as closed. After another four months the builder was surprised to see a van back up to the door with two of the machines on it, and a few days later he received a bill for them from Mr. Purchaser. About four months later he found that his property had been attached by Mr. Purchaser and he had been sued for the value of the two machines and some more. Another four months and the case came to trial. Mr. Purchaser recovered about $50 damages for his bother about the machines while they were being altered in the first place, but had to take them back. Mr. Builder paid lawyers' fees, traveling and costs of court, about $150. Now he does not guarantee to satisfy any one. The money-back plan looks on the surface to be all right. It looks to be the only fair way, and it would be, if the man who buys was always as honest as the man who offers this plan. Suppose you build planers. You offer them on the money-back plan. Out of a thousand customers there will be one whose order you had better fill by going down to the freight office and writing your check for the amount of the freight, out and back, and presenting it to the railroad. They are the only ones that will make anything, any way, and you will save yourself a good lot of expense and worry. Then out of this thousand there will be nine who really want a good tool, but who are crafty and think that you will knock off quite a discount rather than take the tool back; then there will be about another hundred that will honestly think that some accident in the shop or carelessness of their workmen is not their fault, but yours. This will leave you with a hundred and ten planers, out of a thousand, second-hand on your hands and worth about 50 per cent less than your price for new ones. Then there are extra freight charges, etc., and you really must figure on about 10 per cent loss. To meet this, you must add about 11 per cent to your prices. Even then you are just as apt to find the whole hundred and ten returned machines in a single year's work, in which case you are bankrupt before you begin to get a show. If your goods are something that you can just take down off the shelves and send out, and that you can put back and sell again, you can do it on a very small margin of extra price, but when, as is apt to be the case, your machinery is saleable to only a few people, and it cannot be thoroughly tested without making it second-hand, then you must go slow. There are usually certain definite things that a customer needs to have a planer do. A guarantee that your planer will do it within a certain time and within certain limits of accuracy is something that we can all meet, and yet if the customer is not pleased with the color of the paint on the inside of the bed he cannot make you suffer.

The most satisfactory sale I ever made was of a gap lathe. The inquiry came for a lathe to do certain specified work, the most serious of which was a cut of a certain depth and feed on a certain diameter. The diameter called for a 36-inch lathe. We had a 24-inch gap lathe on the floor, so we rolled a motor up alongside, belted it up and put in a 36-inch pulley and found out whether it would take the cut, the same was as the Dutchman found out whether he could drink a keg of beer—by trying it. The result was that we sold a 24-inch gap lathe at a good profit, and our customer bought a lathe that would do just what he wanted at a low price compared with the 36-inch lathe that he expected to buy. ENTROPY.

RECLAIMING OLD METAL BRAKE-BEAMS.

The reclaiming of old bent and damaged metal brake-beams is no small item on a large railroad system, especially with our present heavy equipment putting them out of business regularly. One of the large systems (D. & R. G. Ry.) follows the plan shown in the accompanying cut, of using a $\frac{3}{4} \times 2\frac{1}{2}$-inch or a $\frac{3}{4} \times 3$-inch wrought iron strap as a reinforcing strip on all bulb or I-section beams that fail in service.



Method of Repairing Old Brake-beams.

When bent or damaged brake-beams of this class come into the scrap docks, they are piled to one side, and each month or so a gang of men is set at stripping them of the heads, fulcrums, etc. Then the bare beams are taken to the blacksmith shop to be straightened, after which they are ready to be drilled for the reinforcing strap rivets. They are then taken to an automatic riveter, where the heads, fulcrums, etc., together with the reinforcing strap, are applied. Beams of this type, fitted up in the manner described, give quite as satisfactory service as when they are new, and last much longer. E. W. Bowen.

Denver, Colo.

THE PROPER ADJUSTMENT OF SPARK COILS.

One of the most important adjustments about a spark coil is that of the vibrator spring. The tendency is to set this spring too tight in order to get a "good" spark. This is usually tested in the air, and when a big, heavy spark is obtained, the operator thinks that everything is all right, and starts the engine. The proper adjustment may be secured as follows: Draw the vibrator back until it does not touch the spring. Set the vibrator so that the iron head is from 1/16 inch to $\frac{1}{8}$ inch from the core. Bring the spring up until it touches the vibrator lightly, and start your engine; if it skips, try adjusting the screw a little tighter, but leave the spring just as weak as you can, without the engine skipping. You will find that the battery will last very much longer. Sometimes the battery consumption is increased to three or four times the amount a coil should take by merely setting the spring stiff and getting a "big" spark. Of course, there is danger of setting it too weak, so that when the engine stops, the vibrator spring does not touch the contact screw, and the engine will not start.

We sometimes hear talk of waterproofing coils, but the best plan is to keep them in a dry place, not where they will be hot, but where they will not get damp, as the pressure of the jump spark is so high that it will run along a little streak of moisture almost as well as on a wire, and although the tendency is to dry up this moisture, in so doing it sometimes carbonizes the wood and makes another path for itself. Special care should be exercised on launches to have a good place for the coil and battery. Do not put more than six cells of dry battery or three cells of storage on the coil. If it does not work with this amount of battery in good condition, there is something the matter with it; increasing the voltage will not materially help the spark, and will only burn out the contact points. Secondary or plug wires should not be allowed to remain in contact with a hot pipe or cylinder. They are pretty sure to give trouble sooner or later. Place a piece of wood or fibre between wire and the heated metal. Oil should not be allowed to come in contact with rubber insulation, as oil rots rubber. Do not draw the spark out in the air to see how long it is; this strains the coil, and if there is any weakness, it will be sure to increase the trouble, even if it does not break down immediately.

Another puzzling trouble to find is a wire that is broken inside the insulation. This sometimes happens in the most unlooked for places, but usually where the wires are moved or bent most, as at the commutator, or where there is a great deal of vibration. The break can sometimes be located by bending and pulling, as the wire will be very much weaker and more limber in the broken spot. The spark plugs should be closely watched and kept in good condition. Much of the trouble attributed to the coil may be traced to the plug.

J. E. K.

FACING WORK ON CENTERS.

In the August issue of Machinery the writer finds a kink on the subject of facing work on centers by W. S. Leonard. It astonishes some of his readers why he does not use the so-called half-center for such work. It appears as if Mr. Leonard were totally unacquainted with this appliance. Supposing it is wanted to cup the end of an arbor for holding work between centers, how would it be possible to do by using ordinary centers, unless by slacking the tail-center. For all such purposes the old style of center should be discarded, and the so-called half-center be used.

Beverly, Mass. Clarence E. Simonds.

STEAM WHISTLE OPERATED BY GAS.

In the August issue of Machinery, W. L. McL. suggests putting a steam whistle on the cylinder of a gasoline yacht engine. I would like to inform W. L. McL. that on an ordinary-sized yacht engine that is the best way he can find for spoiling his compression and the efficient running of his engine. Arthur Knapp.

Ardmore, Pa.

[Mr. Knapp's objection, we suppose, is that screwing a pipe into a gas engine cylinder head will increase the clearance space an amount equal to the space in the pipe up to the valve. Of course it is possible to avoid this by decreasing the original clearance space an equivalent amount. In any case the valve should be close to the head.—Editor.]

* * *

In every work of genius we recognize our own rejected thoughts.—*Emerson.*

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

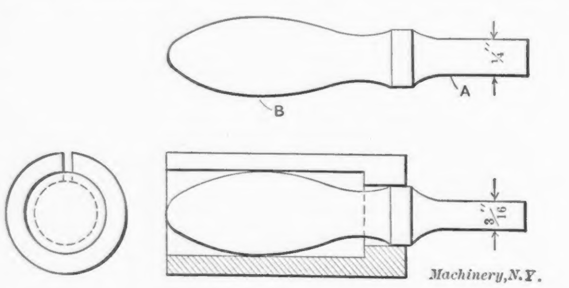
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

BABBITTING KINK.

Another way than that mentioned in the August issue, of babbiting a solid box in a hurry and not have to scrape it, is to take a piece of paper, rub it with Albany grease, and wrap it around the babbitting mandrel. The grease will make the paper stick until the babbitt is poured, and will help it to run freely. After pouring, drive out your mandrel, clean out the paper, and the box is ready. ALLAN.

HOLDER FOR TURNING END OF HANDLES.

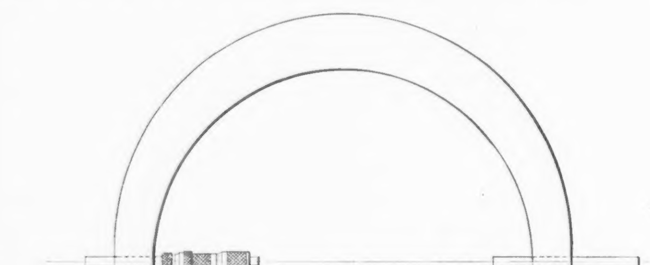
A job came up one day requiring a number of handles, as shown in the cut, to be turned down at *A* from a diameter of ¼ inch to 3-16 inch. I tried chucking them at *B*, but found



that it took considerable time to true them up, and very little pressure to knock them out of true again. Finally, I made a holder, as shown in the cut. This holder is simply a split bushing with a shoulder at one end. By this means I could grip the handles firmly, and hold them true for turning with very little trouble. ORIGINAL.

MICROMETER FRAME.

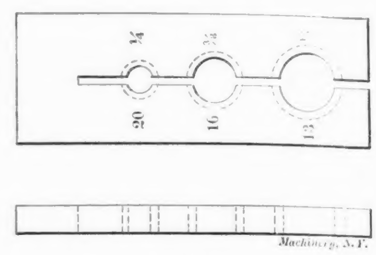
The accompanying cut shows a micrometer frame which I used some years ago at the Westinghouse works. The frame is an aluminum casting, and the anvil is simply a tool-steel pin, which fits well in the hole into which it is inserted, and can be clamped anywhere within the limits of its length. The



micrometer end of the frame is supplied with an inside micrometer head. The tool is adjusted to a gage, either to a standard pin gage, or to an inside micrometer gage. The capacities of three of these micrometers in a set were from about 3½ to 7 inches, 6 to 11 inches, and 10 to 15 inches. When the head was turned outward, as shown in the lower view in the cut, the tool was very handy around a horizontal boring machine where a pin gage could not be used without removing the boring bar. SIRIUS.

A SCREW FILING JIG.

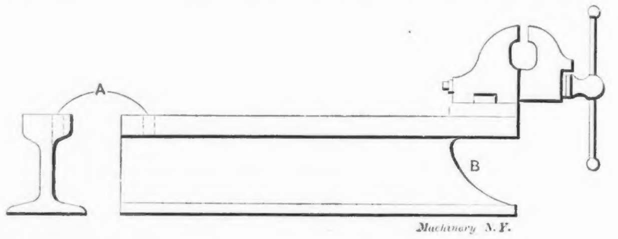
A clever little device for holding screws while filing the ends to shorten the length came to my notice a short time ago in a shop where many varying lengths of screws were needed. It was impracticable to buy all the various lengths, so a file was used. The screw, if held in a vise or hand clamp was sure to have the threads jammed, hence the jig shown was devised. The jig consists of a strip of brass, 3/16 inch thick. Three holes were drilled, tapped and marked. Then a saw cut was taken through the piece to the last hole. The screw can be put into the right hole, then the jig held in a hand clasp or a vise, and the file used without fear of bruising the threads. This works to perfection, and the plate can be tapped for a great number of sizes of screws, if desired. RAYMOND C. WILLIAMS.



Worcester, Mass.

BENCH VISE ANVIL.

The accompanying cut shows a very handy bench vise anvil for the tool-room, model-maker, or amateur mechanic. The anvil is made from a piece of steel T-rail about 12 or 15 inches long, and as heavy as can be obtained, and the top, edges and ends are planed smooth, true and square. The web is cut out, as shown at *B*, so a clamp or swivel vise of about 1½ or 2-inch length of jaw can be fastened to the end of the rail. There is a taper hole at *A* for different shaped stakes. The top and edges may be case-hardened if so desired. This makes an exceedingly handy outfit, as a great variety of work can be executed on it, and the vise can be brought in the best

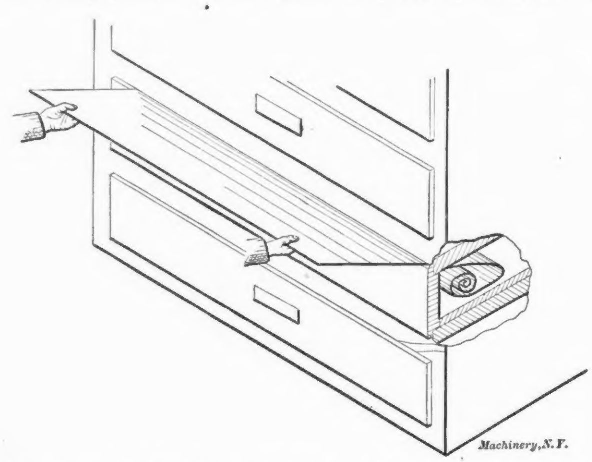


position to see the work. The top is a good place for straightening work, and the edges for bending work. Pieces of suitable sized rails can be easily obtained from section foremen on almost any railroad. X. Y. Z.

[Perhaps *some* railway officials might object to X. Y. Z.'s naïve statement as to the ways and means of getting suitable sections of rail as an unwarranted incitement to breaking the eighth (seventh, Douay version) commandment.—EDITOR.]

SMOOTHING WRINKLED BLUE-PRINTS.

The cut shows our method of "ironing" soiled or wrinkled blue-prints after they are dry. The wrinkled print is laid in a cabinet drawer with just enough of it outside to conveniently hold in the hands, and the drawer is tightly closed. After being pulled out the print is perfectly smooth. The



angle of pull should be adjusted to the strength of the paper. Pulling through once will, of course, cause the print to roll up, when released; if this is not desirable, and the print is wanted to lie flat, reverse the print and pull through once more. HOWARD D. YODER.

Wadsworth, Ohio.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

In the July issue of MACHINERY, C. H. A. asks if there is any sure way of plating by dipping in copper sulphate so as to obtain a good plating, and also asks what is the correct solution. The best results are obtained by using a solution of 3 pounds of sulphate of copper to 2 fluid ounces of sulphuric acid. The surfaces to be plated must be carefully cleaned, so as to be free from dirt and grease. With the above solution good results are certain, and any reasonable desired thickness of plating can be obtained.

Scottdale, Pa. M. B. STAUFFER.

DEPTH OF THREAD IN PIPE FITTINGS.

A. B.—Do manufacturers of pipe fitting follow or agree on a common standard in the depth of thread that shall be tapped in fittings supplied to the trade? Is there a published record of same?

A.—The Briggs standard of pipe thread gives practically all the data required. The taper of ¾ inch per foot makes no precise standard of depth necessary, but, of course, where test plugs are used for inspection, certain arbitrary standards are necessary. The extra data sheet No. 78, made ready this month, on pipe threads and gages, gives the tool-room practice of one large manufacturing company.

TO LOOSEN A PULLEY ON A SHAFT.

N. M.—I have a number of 48-inch pulleys rusted fast on 2 7/16-inch shafts. I have tried almost every mechanical means known, short of hydraulic pressure, to start them, and so far have failed. The pulleys appear to be "welded" to the shafts with a dry, hard rust. I have tried to soften the rust with kerosene, gasoline and alcohol, but none of these apparently does any good. What would you advise?

A.—We would advise heating the hubs and lightly hammering them, and the continued use of solvents such as kerosene or alcohol, but probably heavy pressure will be required to start the pulleys loose. This, of course, is best supplied by a hydraulic press, but threaded rods may be rigged so as to obtain almost any pressure that is likely to be required in this case. The question is submitted to our readers.

DISTINCTION BETWEEN PITCH AND LEAD.

E. C. D.—Admitting that a screw and worm are essentially the same thing, why is the pitch of a screw known as the distance traversed during one revolution of the screw, and the pitch of a worm the distance from center to center of adjacent threads, regardless of multiple threads.

A.—This inquiry illustrates why a distinction should be made in the use of the terms "pitch" and "lead." Pitch should always be regarded as the distance from center to center of adjacent threads, irrespective of lead, while the lead should always be regarded as the axial distance traversed by one revolution of the screw without reference to the number of threads. In the case of single-thread screws or worms the pitch and lead are the same, but in the case of multiple-thread screws the pitch and lead are different, hence the desirability of always observing the distinction in meaning.

FEED MOTION GEAR TRAIN FOR BORING BAR.

W. H. S.—I wish to convert an old engine lathe into a boring lathe, using the boring bar shown in Fig. 1. The feed screw in the boring bar has four threads per inch, and is driven by the transmission gears *A* and *B*, having 14 and 32 teeth, respectively. The feed motion is to be transmitted to the center gear *B* by a square end bar *C*, shown in Fig. 2, which works through the hollow spindle, and is connected to the spindle through the back gear by a suitable train. The pinion *D* is connected to the feed bar by friction disks, which are released to stop the feed. The feed is reversed by the shifting spool-gear *E*. The pinion on the back gear shaft has 15 teeth and the spindle gear 73 teeth. What numbers of teeth will be required in the gear train to give the required feed in either direction?

A.—Since the feed screw has ¼ inch lead, and the gears are 14 and 32 teeth, a feed of 3/64 inch per revolution will require a differential movement of the feed bar *C* of $3/64 \div (\frac{1}{4} \times 32/14) = 21/256$. That is, the feed bar must run 21/256 turn slower or faster than the boring bar to give a feed of 3/64 per revolution. Expressed in another way, the feed bar must make 235 turns for 256 turns of the boring bar to feed the head to the left and 277 turns for 256 turns of the boring bar to feed the head to the right. Aside from the method of finding the proportions of the spool-gears *E* and E_1, perhaps, there is nothing different from the common trial-and-error operations followed in proportioning feed

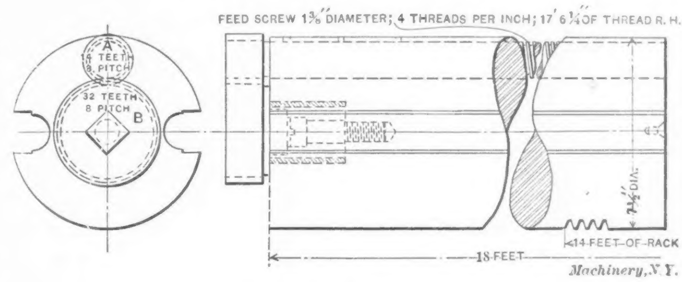


Fig. 1. Boring Bar Used.

gear trains, with which all machine designers are more or less familiar. If we make the two-spool gears with the same respective numbers of teeth, the squares of the tooth numbers must be in the ratio of 235 to 277 in order to preserve the required rate of feed in either direction. The numbers of teeth should be less than 100—preferably from 40 to 60. Hence we will multiply 235 and 277 by some factor which will yield products whose square roots will be numbers between 40 and 60. By a series of trials we find that the near multiples 2209 and 2601 yield roots 47 and 51, which

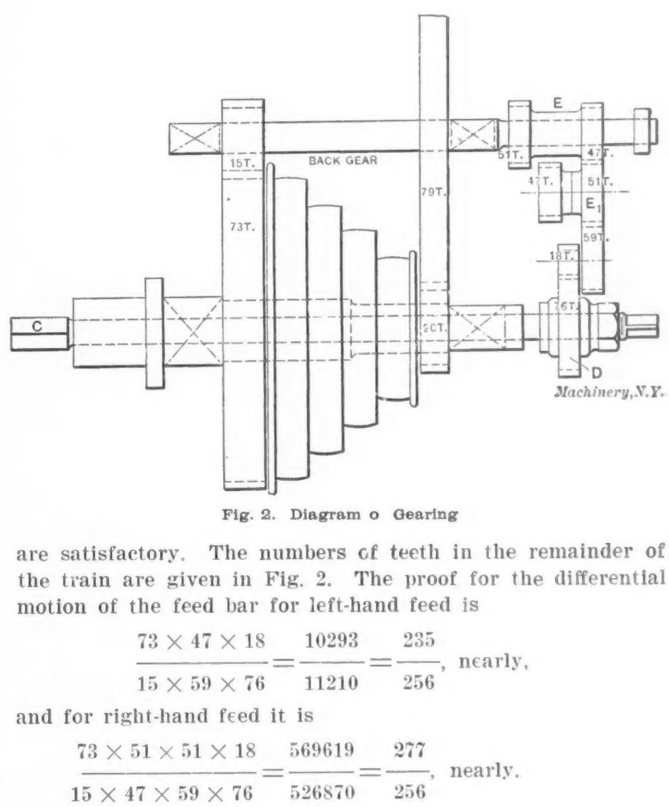


Fig. 2. Diagram o Gearing

are satisfactory. The numbers of teeth in the remainder of the train are given in Fig. 2. The proof for the differential motion of the feed bar for left-hand feed is

$$\frac{73 \times 47 \times 18}{15 \times 59 \times 76} = \frac{10293}{11210} = \frac{235}{256}, \text{ nearly,}$$

and for right-hand feed it is

$$\frac{73 \times 51 \times 51 \times 18}{15 \times 47 \times 59 \times 76} = \frac{569619}{526870} = \frac{277}{256}, \text{ nearly.}$$

* * *

In the August issue a description was published of the Besly disk grinder, having 26-inch steel disks, with the intimation that it was the largest disk grinder ever built. In this we were mistaken. C. W. Burton, Griffiths & Co., London, inform us that they build a 40-inch disk grinder, and that one was exhibited at the Engineering and Machinery exhibit held at Olympia Exposition, London, 1906. This large machine is built either with motor or belt drive. The work tables are about 18 x 27 inches and are carried on ball bearings. They are provided with T-slots and are traversed by rack and pinion. Adjustment in and out from the disks is effected by a micrometer feed screw. The approximate weight is 6,700 pounds, or over three times the weight of the grinder illustrated in the August issue.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

GRANT-LEES GEAR GENERATING MACHINE.

Any one who has followed the trend of development in machine tools in the past few years, must have noted the growing tendency toward the use of generating processes for the cutting of gear teeth. In the past two or three years, especially, much time and thought has been given to the process of generating gear teeth with a hob, whose normal outline has the form of the rack tooth of the interchangeable

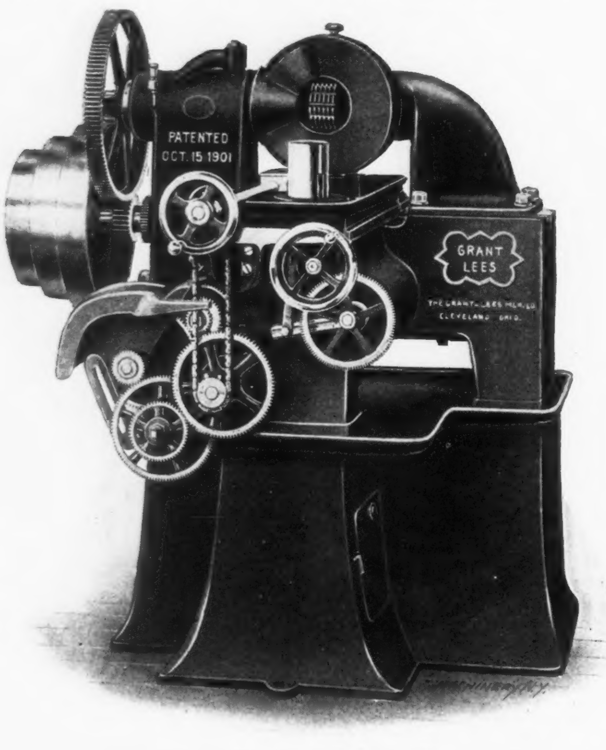


Fig. 1. Grant-Lees Gear Generating Machine. Front View.

set to which the gear belongs. The machine illustrated in the accompanying cuts, and described in the following paragraphs, is the latest product of this kind which has been brought to our attention. So far as we know, it is the first machine working on the hobbing principle for cutting spur gears that has been regularly built for the market in the United States. It is radically different in its constructional features from the European machines which have preceded it in this field, and contains a number of improvements which make a study of its details well worth while.

The general requirements of a hobbing machine for gear cutting are as follows: Means must be provided for driving the hob powerfully and smoothly at any angle with the axis of the work, so that spiral gears as well as spur gears may be cut. A work spindle, stiffly supported, must be provided, driven by a worm-wheel connected to the cutter spindle through change gears, so that the proper relation between the work and the cutter may be established to give the required number of teeth. Either the work spindle or the cutter spindle must be mounted on a slide, so that the center distance between the work arbor and the cutter arbor may be adjusted to give the proper depth of tooth. Either the work must be moved past the hob, or the hob past the work for the feeding motion, suitable means being provided to vary this rate of travel in accordance with the depth of cut and the hardness of the materials used. In addition to this, the feed of the work must be connected with the work-revolving mechanism by change gears, to give the proper movement for cutting spiral gears independently of the rotation of the work with the hob. These various movements and adjustments must be obtained in a way which will still allow the machine to have great rigidity, to prevent the deflections and inaccuracies which must otherwise result from the heavy cutting strain which the process involves. The solutions of these problems offered in the Grant-Lees machine will be understood from the cuts and the description.

As will be seen, the machine has the general appearance of the Lincoln type of miller, which is used so largely for heavy form cutter milling in repetition work. The power is transmitted from the cone pulley through reducing spur gearing to a bevel pinion meshing with the main driving bevel gear. This latter has a wide face, and engages, at the inner ends of its teeth, in addition to the driving pinion, with a second beveled pinion, keyed to the cutter spindle of the machine. The whole arrangement is shown quite plainly in Figs. 1, 3, and 5. The main driving bevel gear is in the form of a ring, revolving on a hub on the cross rail of the machine. The bracket carrying the cutter spindle has a long shank which passes through a hole in the center of this hub, and carries on its back end a graduated dial with suitable handles for setting it at the angle required for the work, and means for locking it in the desired adjustment. These arrangements are plainly shown in the rear view of the machine, Fig. 2.

The work is set on a hardened and ground tool steel arbor on a spindle having a vertical movement for the feed. The power for rotating the work spindle in unison with the hob (necessary in this machine, as we have just seen) is taken from the cone pulley shaft through change gears on the right side of the machine in Fig. 2, to the worm meshing with the index wheel on the spindle. The feed is obtained by a mechanism which raises the spindle as the cut progresses, the feed variation being obtained by change gears at the front of the machine as shown in Fig. 1. When the work has been fed in to depth, by adjusting horizontally the slide which carries the work spindle, to figures read on the dial of the handwheel governing this movement, the cut may be started, and the work will be fed up past the revolving hob until the full width of face has been cut, whereupon feed will be stopped, the work withdrawn and returned to its previous position, and a gong will be struck to announce the completion of the work. The machine is, to this extent, automatic.

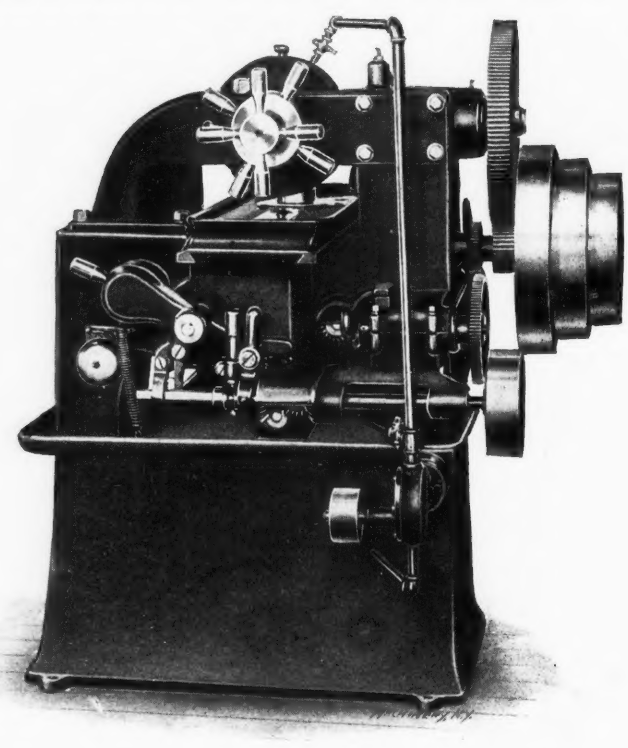


Fig. 2. Rear View of Gear Generating Machine, showing Feed Mechanism.

Figs. 1 and 2 show the front and rear views respectively of the machine, giving clear ideas of the general construction, and of the ingenious way in which the driving motion is conveyed to the hob, giving it a powerful drive and still allowing it to be swiveled at any angle. Ordinarily the driving

gear is covered by a case or cover, as shown in Fig. 1. Fig. 3 shows the machine cutting spur gears. The hob used, shown in Fig. 4, has teeth with a normal outline of the shape of the rack tooth, as explained.

Fig. 5 shows the machine cutting spiral gears. This is done as readily as the cutting of spur gears, it merely being

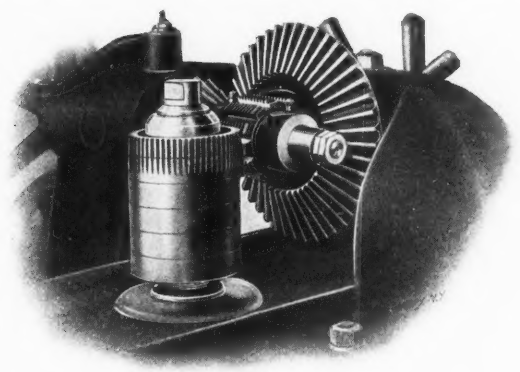


Fig. 3. Cutting a Stack of Spur Gears.

a matter of setting the hob at a proper angle and using the proper change gears for the spiral rotation of the work with the feed. The change gears for this motion are also located at the front of the machine. The connection with the index worm and wheel is presumably through some form of differential or "jack-in-the-box" gearing, so that the rotation of the work for the spiral, in connection with the feed motion, is superimposed on, and independent of, that due to its connection with the hob.

Fig. 4. The Hob Used in Generating Gears.

Fig. 6 shows a worm-gear being hobbed. For this operation the hob spindle is placed in a horizontal position, and the work is fed directly in toward the hob at the proper rate, and stopped at the proper depth, no previous nicking of the blank being required. The feeding motion for this, so far as can be judged from Fig. 1, is of the ratchet type, being adjusted by varying the position of the crank-pin in a slotted link.

Fig. 7 shows an ingenious steady rest, used for work of large diameter. Since the entire work spindle and the work

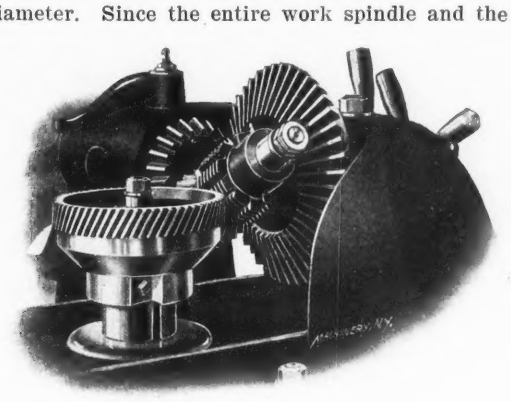


Fig. 5. Cutting a Spiral Gear.

it holds are raised to feed them past the hob, it is necessary also to raise any form of steady rest which might be used at the same rate as the work. The rest takes the form of a threaded post, raised by a nut geared through the worm and chain gearing shown to the vertical feed gearing at the front of the machine. The raising of the work and of the steady rest thus takes place simultaneously, and at the same rate. The attachment is shown in place in Fig. 1.

There are several advantages at once evident in this system of generating gear teeth. One cutter only is needed for each pitch, cutting all the gears from the smallest to the largest number of teeth. The fact that all the gears for a given pitch are cut by one correct hob, eliminates the errors arising from using one cutter for a considerable range of numbers of teeth in the old system. Another consideration which tends toward accuracy is the fact that the heat is uniformly distributed, owing to the fact that the work is continuously rotated. Since each tooth of the hob passes over each of the teeth of the gear, it is impossible for a gear cut on this machine to have thick or thin teeth, since all are cut under exactly the same conditions.

Another advantage of the system is its universality. The same machine is fitted to the cutting of spur, spiral and worm

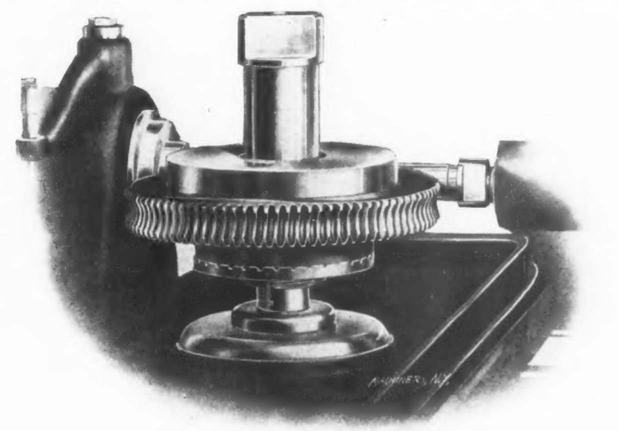


Fig. 6. Hobbing a Worm-wheel.

gears without requiring extraneous attachments, all the movements being provided for in the design of the machine. There is a great gain in simplicity as well, in this process, over the automatic gear cutter of the usual type, which is required to be provided with mechanism for feeding the cutter, returning it at high speed, indexing the work, and repeating the operations with rapidity and precision. Especially does the advantage of the generating machine appear when it is contrasted with a machine of this type adapted to the cut-

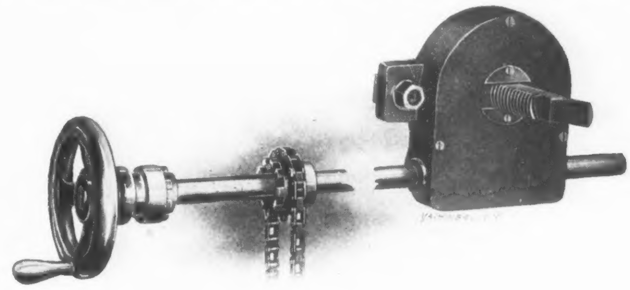


Fig. 7. Automatic Steady Rest, shown in Place in Fig. 1.

ting of spiral gears. It is difficult to escape the conclusion that there are great possibilities in store for the hobbing process of generating spur and spiral gears.

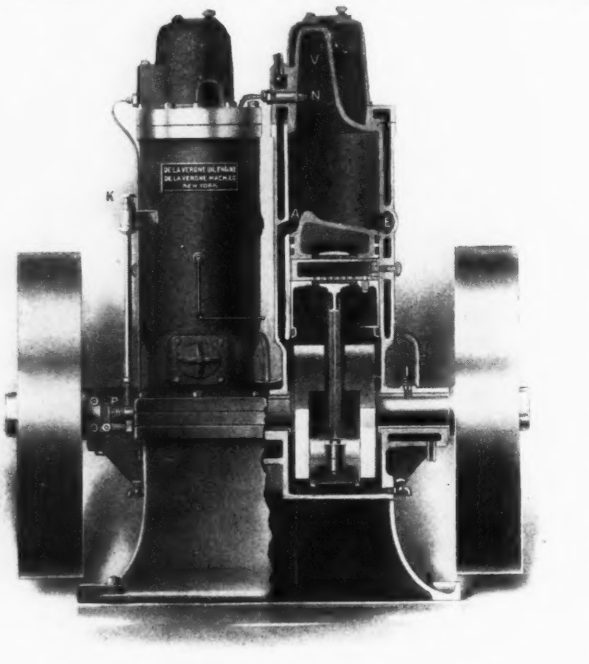
This machine is the result of the combined efforts of Mr. H. J. Lees and Mr. John J. Grant, the former well known as a pioneer in the development of the heavy multiple spindle milling machine, and the latter recognized as one of the most original and ingenious machine tool designers in the country. The Grant-Lees Machine Co. of Cleveland is building the machine and placing it on the market.

DE LA VERGNE TWO-CYCLE VERTICAL OIL ENGINE.

For the past twelve years, the De La Vergne Machine Co., New York, has built the Hornsby-Akroyd oil engine in sizes up to 250 H.P. With the valuable experience gained in the design and construction of this engine to guide it, the company has developed a two-cycle two-cylinder vertical oil engine designed for small powers. At present it is built in two sizes only—

7½ and 15 horse-power. The new engine uses ordinary kerosene or fuel oil. Kerosene is available everywhere, and in most sections can be purchased for about one-half the cost of gasoline. With kerosene at 10 cents a gallon and gasoline at 17 cents a gallon it is calculated that power developed from kerosene costs less than one-half as much as power developed by gasoline. The two-cycle engine has the advantage over the four-cycle type that the piston receives an impulse every revolution, and in a two-cylinder two-cycle engine the crankshaft receives two impulses every revolution the same as that of a single-cylinder double-acting steam engine.

Referring to the sectional part of the cut, air is admitted to the cylinder from the crank case through the port *A*, which is uncovered by the piston near the end of the downward stroke. The beginning of the upward stroke closes the fresh air port *A* and the exhaust port *E*. The air thus trapped is compressed into the vaporizer *V* at the head of the cylinder. A spray nozzle *N* projects into the vaporizer, and through



De La Vergne Two-cylinder Oil Engine.

this a charge of atomized oil is sprayed against the hot walls of the vaporizer. The spray is forced into the vaporizer by the plunger pump *P*, which is driven by a cam on the crankshaft.

The vaporizer is similar in construction to that used on the Hornsby-Akroyd oil engine, being a cast iron bulb on the cylinder head and forming an extension to same. No sparking device or hot tube is used. The walls of the vaporizer retain sufficient heat to vaporize each successive charge of oil, and ignition is effected by the heat of the vaporizer walls together with the heat of compression. Slightly before the end of the downward stroke the exhaust port *E* is uncovered, permitting the escape of burned gases, and on the upward stroke fresh air is drawn into the crank chamber through an automatic poppet valve. On the downward stroke this air is slightly compressed, and when the air port *A* is uncovered the fresh air rushes into the cylinder.

It is evident from the above that the construction is essentially that of the typical two-cycle engine; the design has been modified and improved with the view of obtaining all the advantages of the two-cycle type and of avoiding its defects. The fuel consumption is about one pint of kerosene or fuel oil per brake horse-power hour, and fuel consumption not to exceed one pound per brake horse-power hour is guaranteed when running at three-fourths to full load.

THE BURKE TAPPING MACHINE.

The half-tone shows a tapping machine made by the Burke Machinery Co. of Cleveland, Ohio. The spindle carries a chuck for holding the taps. Mounted on it are two pulleys, one of which is driven by a straight and the other by a cross belt. The spindle may be connected with the forward moving pulley by shoving it inward, or may be disconnected from this and connected with the reversing pulley by drawing it downward. These connections are effected by two expanding ring clutches, one in each pulley, operated by the end motion of the spindle. The work is held by the hand against the plate, shown attached to the bar passing through the base of the head-stock. This foot-stock bar slides freely in its bearings, and is provided with an adjustable stop for limiting its

Burke Horizontal Tapping Machine.

inward motion. When the work held against the plate by the hand is pressed against the tap, this pressure connects the spindle with the pulley which gives the forward movement. When the hole has been tapped to depth, as determined by the adjustable stop, the continued rotation of the tap draws out the spindle and so disconnects it from the forward motion, whereupon the withdrawal of the work puts the reversing pulley in connection with the spindle, and the tap is backed out.

The foot-stock bar has a movement of 3½ inches. The machine has a capacity for tapping holes up to 3/8 inch in diameter. Unless otherwise ordered, it is furnished with a 5/16-inch chuck, without extra charge. The spindle will be tapered to fit a No. 2 Almond chuck, if the purchaser desires. The pulleys are 6½ inches in diameter for 1¾-inch belt, and are intended to run at about 100 revolutions per minute. The net weight of the machine is 40 pounds.

CHAPMAN DOUBLE BALL BEARING.

The ball bearing made by the Chapman Double Ball Bearing Co., 40 Bristol St., Boston, Mass., has, as the special feature of its design, an arrangement by which friction between neighboring balls is eliminated. A lot of balls running together in a bearing under pressure have a tendency to crowd together, and it is the belief of the makers of this bearing that a large

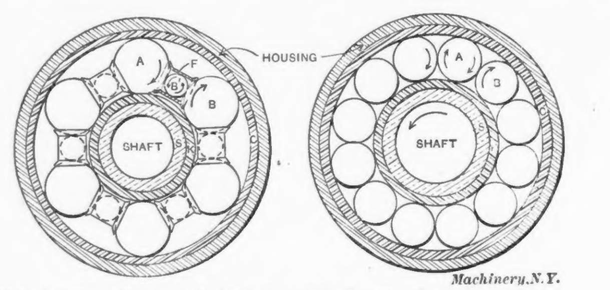


Fig. 1. Use of Intermediate Ball in the Chapman Bearings. Fig. 2. The Cause of the Friction in Ordinary Bearings.

share of the loss of power, and the larger part of the wear to which the balls and races are subjected, can be traced to this crowding tendency, and the consequent friction of the balls on each other. The means taken to prevent this will be understood by referring to Figs. 1 and 2. In Fig. 2, which shows the ordinary bearing, balls *A* and *B* rotate in the same direction, as shown, when the bearing is in action. This, it will be seen, makes the two balls rub against each other at the point of contact, since the surfaces are moving in opposite directions at this point.

Fig. 1 shows the method of obviating this difficulty. A small ball *B'* is inserted between *A* and *B* on the line of cen-

ters between them, so there is no tendency for it to move out of position. It is held here by a light spool or bushing *F*, which is beveled at the ends to rest lightly against the large balls *A* and *B*, and has a central hole just large enough to allow the small ball *B'* to rotate freely. It will thus be seen that, barring the entirely negligible weight of the spool *F*, there is nothing except rolling friction to be considered in the whole bearing. The makers consider that this method of separating the balls is much preferable to the use of a cage, in which case the friction is merely transferred to the sides of the container instead of taking place between the balls themselves, as in the ordinary old-style bearing.

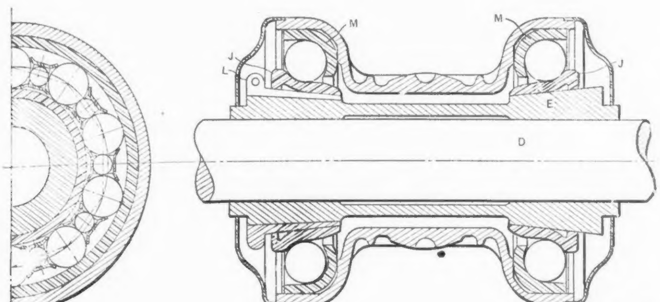


Fig. 3. The Chapman Ball Bearing for Shaft Hangers.

The application of this arrangement to hangers and other shafting bearings will be perhaps as interesting to the readers of MACHINERY as any of the numerous uses to which it has been put. A hanger equipped with a Chapman bearing is shown in Fig. 4, while Fig. 3 is a cross section explaining the construction followed. *D* is the shafting to be supported, and *E* is the sleeve on which the inner ball races are mounted. Races *J* and *J* are mounted on the sleeve, one at the right-hand, and the other at the left over an adjusting collar *L*. This may be moved in or out to adjust the bearing to the proper degree of play. It will be noted that the inner races *J* and the outer races *M* are both unsupported directly behind the line of thrust. A slight elasticity is thus allowed which permits the bearing to take care of minute irregularities due to temperature changes, etc., while still leaving the parts rigid enough to support any weight which may be put upon

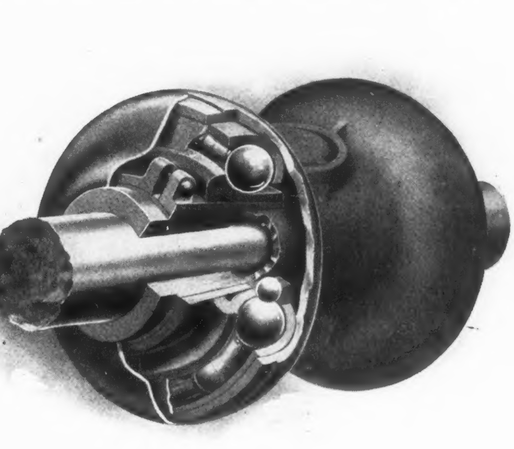


Fig. 4. Sectional View of the Hanger Bearing.

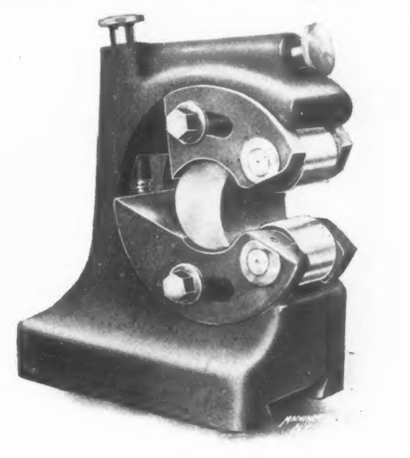
them. In addition to this, the complete bearing is free to swivel in the hanger to adjust itself to the axis of rotation of the shaft.

A number of tests have been made by a competent engineer comparing the efficiency of the Chapman bearing, the ordinary ball bearing, and the plain journal, the workmanship in each case being of the same quality. These tests were made in various ways. One of the simplest of them was carried out with an apparatus consisting of three exactly similar cast iron pulleys, perfectly balanced and weighing 105 pounds each, mounted on a central axle The first of these ran on a Chapman double ball bearing, the second on an ordinary three-point ball bearing of similar design, and the third on a plain journal of hardened and ground steel, running in a cast iron hub. A 7-pound weight was hung by a small cord from the periphery of each pulley in turn, at a height of 10 inches from the floor. Then the weight was released, and the number of revolutions that each pulley made before it came to a stop, as well as the duration of the spin, was noted. The Chapman bearing rotated for 16 minutes and 35 seconds, the ordinary ball bearing, 5 minutes 8 seconds, and the plain journal, 20 seconds.

LODGE & SHIPLEY ROLLER FOLLOWER REST.

The tendency of work carried on centers to spring away from the tool under the pressure of the cut is more pronounced with the high speed attainable with modern tool steels than was the case under former conditions. At the same time, the use of the follow rest to counteract this tendency has been made less satisfactory, owing to the coarser chip, higher speed and rougher surface left by the new steels. The jaws are rapidly worn away, and rubbing friction is a fruitful source of lost power. The half-tone shown herewith illustrates a follow rest in which these difficulties have been overcome.

The body of the follow rest is clamped to the dove-tail slide of the bridge of the carriage. The two jaws can be separated or brought together by a circular motion, effected by two screws meshing with teeth in these jaws; the screws are operated by the knobs shown at the top of the device. The jaws carry hardened steel rollers, and are so located as to give, with the point of the tool, a three-point support to the work. When once set, the device is adapted for a variety of diameters by simply moving the entire rest backward or forward by its connection with a screw which telescopes through the regular cross feed screw, and is operated by the hand-wheel controlling the tool rest. When approaching a shoulder, the position of the rolls is such that they support the shaft on the smaller diameter until the cutting tool has turned a portion of the larger diameter, when the rollers may be quickly brought to bear upon it. Ample provision is made for oiling. Sensitive adjustment is provided for, without the aid of the wrench, and the jaws, once set, can be locked in position.



Follower Rest for High-speed Turning.

This follow rest is made by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

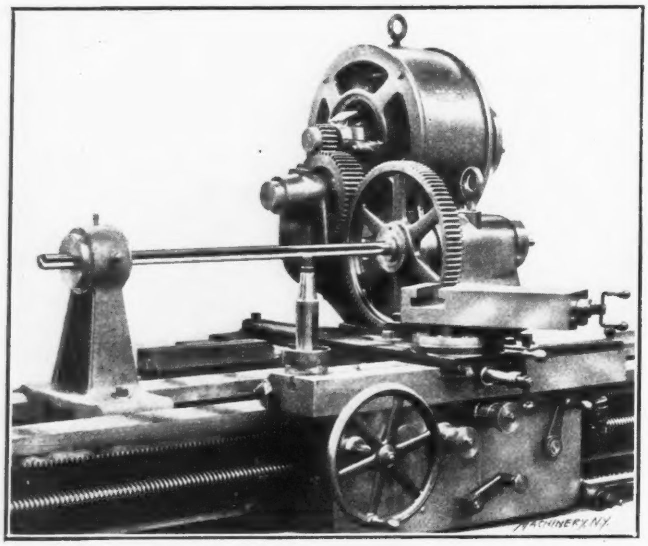
DEEP DRILLING ATTACHMENT FOR THE LATHE.

An attachment is shown in the accompanying half-tone for performing deep drilling rapidly and economically on the engine lathe. It consists essentially of a drill spindle, mounted on the cross slide in place of the usual tool-post, in combination with an electric motor and suitable gearing for rotating the spindle. A support is provided for holding the outer end of the work, the other end of which is clamped by the chuck or face-plate of the lathe. Provision is also made for forcing a copious supply of lubricant to the point of the drill used. The purpose of the attachment is to make it possible to drill a hole true with the center line by the usual method of rotating the work, and at the same time give the high cutting speed of which high-speed tools are capable, without necessitating a high rate of revolution for the heavy spindle and gearing of the lathe.

The drill spindle bearing, with the bracket on which the motor is mounted, is cast as one piece with the bed plate. This plate is bolted to the wings or arms of the carriage. The 3-horse-power 2 to 1 variable speed motor shown, is connected to the drill spindle through an intermediate raw-hide

gear. The spindle is bored to supply lubrication to the drill; it has a large bearing, and is ring oiled. The drill shank is fitted to the hole in the spindle by reducing bushings. The outer end of the drill is carried in a free bushing, revolving in a support bolted to the lathe bed. The drill used is of the special construction known as the "Chard" deep drill. A flat blade of high-speed steel is held in position at the end of a steel shank by a tapered pin; it is so ground as to break up the chips and thus facilitate their removal. Lubrication under pressure sufficient to clear the chips and cool the cutting edge is supplied by a pump, attached to the lathe at the rear of the head-stock, and driven from the lathe counter-shaft. Flexible tubing connects this pump with the hollow spindle through a nipple at the rear. Two copper tubes, flush with the surface of the drill, carry the lubricant to the cutting edge. This type of drill has been in use for some time on lathe spindles, back gear sleeves and pulley sleeves. Under favorable conditions a 2-inch drill has been advanced at the rate of 2¼ inches per minute. The drill in the cut is 1 inch in diameter.

This whole attachment may be easily removed from the carriage by the use of an over-head crane, suitable I-bolts



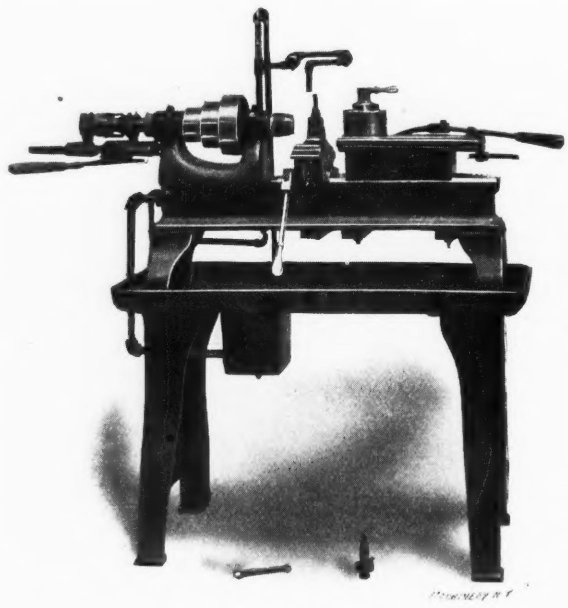
Motor-driven Attachment for Deep Drilling in the Lathe.

being provided for this purpose. Only a few minutes time is required to change the machine over to engine lathe work. The particular machine illustrated is used regularly for drilling central holes in locomotive driving axles, the hole being 1 inch in diameter and 44 inches deep. It was built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

WELLS SCREW MACHINE.

This is a small machine of inexpensive design and construction, intended to be used for a large range of work originally done on more elaborate machinery. The machine is stiffly made, as may be seen from the cut, the head-stock being cast solid with the bed. The other parts, such as the turret slide, cross slide, etc., are provided with ample bearing surfaces and plenty of metal to resist the strains imposed on them when taking cuts with high speed tools. The spindle is fitted with an automatic chuck operated by a lever. The wire feed used is not of the ordinary chain actuated type, but instead follows the plan generally used in automatic machines, an inside tube and collet or finger being used to grip the stock, and feed it forward against the stop in the turret. This is operated by the same lever that works the chuck. This reduces the capacity of the wire feed, but has the advantage that the bar is under the control of the feed until it is entirely used up. For larger work the inside tube and collet can be taken out at any time, and hand feed used with the automatic chuck. The spindle is so designed that the cap may be taken off and any lathe chuck up to 8 inches in diameter used for holding large work, such as castings, etc.

This machine will be furnished with either a 4-hole hand operated turret, or a 4 or 6-hole automatic turret, with or without the wire feed just described. The equipment regularly furnished includes one automatic chuck and feeding collet for ½-inch wire, the turret slide and cross slide shown, oil pump and piping, and a friction clutch reversing counter-shaft. The machine swings 11 inches over the bed and has a 1⅛-inch hole through the spindle. The automatic chuck has a



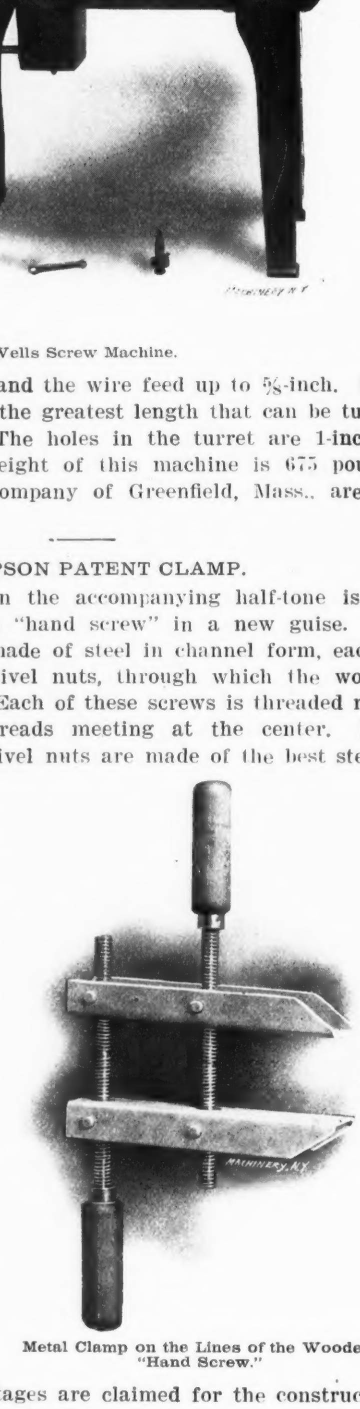
Wells Screw Machine.

capacity up to ⅞-inch and the wire feed up to ⅝-inch. Four and one-half inches is the greatest length that can be turned by the turret tools. The holes in the turret are 1-inch in diameter. The net weight of this machine is 675 pounds. F. E. Wells & Son Company of Greenfield, Mass., are the builders.

THOMPSON PATENT CLAMP.

The clamp shown in the accompanying half-tone is our old friend the wooden "hand screw" in a new guise. As shown, the jaws are made of steel in channel form, each of them carrying two swivel nuts, through which the wooden handled screws pass. Each of these screws is threaded right- and left-hand, the threads meeting at the center. Both screw spindles and swivel nuts are made of the best steel.

The clamp is opened and closed rapidly by grasping the handles in the two hands and rotating the clamp like a reel, the same as with its wooden progenitor. It has the added advantage, however, of allowing either screw to be adjusted without moving the other, so that the jaws may be set to incline toward each other, or away from each other, as well as in a parallel position. This is allowed by the use of the swivel nuts.



Metal Clamp on the Lines of the Wooden "Hand Screw."

The following advantages are claimed for the construction. The jaws being made in the form of a channel and of a good quality of steel, makes the clamp much stronger than any other. Owing to the rigidity of the design, this strength is obtained without sacrificing lightness. The jaws and screws being of metal, glue will not adhere to them. The jaws can be adjusted to any angle. It is twice as fast in operation as the old style, on account of the use of right and left thread

on the spindles. Owing to the use of metal screws and nuts, a stronger hold is obtained with less power. The jaws, which are polished, may be made to over-lap. The Erie Stamping and Mfg. Co., Erie, Pa., manufactures the clamp.

BULLARD RAPID PRODUCTION VERTICAL TURRET LATHE.

The Bullard rapid production vertical turret lathe is built by the Bullard Machine Tool Company, 531 Broad Street, Bridgeport, Conn. The steps by which this machine has arrived at its present form, as shown in the accompanying cuts, are typical of the process of development that machine tool

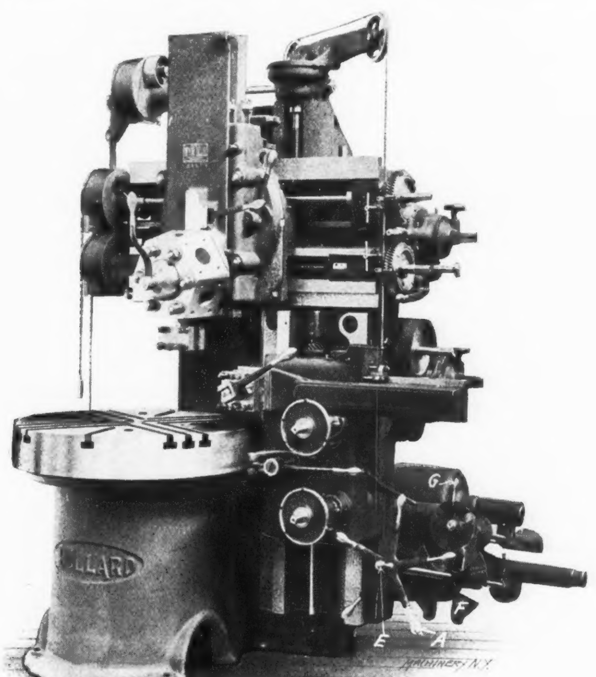


Fig. 1. Bullard Rapid Production Vertical Turret Lathe.

design has gone through in the past few years, showing both the growth of the requirements which the builder has to meet, and the line of development which the machine has had to pass through to meet these requirements.

The boring mill is essentially a lathe, set on end for convenience in handling work of large diameter and comparatively short length. Being a lathe, the turret was naturally applied to it at about the time the turret lathe began to approach its present state of development. In larger mills, the use of two turrets was naturally suggested, owing to the room available on the cross rail, and the desirability of having as many tools cutting at once as possible. In the boring mills of smaller sizes, however, the carrying out of this idea was found to be impracticable, since in many cases the use of two heads required the second one to be swiveled to an excessive degree and extended from its supporting saddle to a point where the two tools could be used in close proximity. This extension of the tools beyond their supports resulted in a reduction in the feeds and speeds possible, owing to the lack of rigidity in the support, so that very little gain was found in the use of two turrets over that of the single tool.

A few years ago Mr. E. P. Bullard, Jr., of the Bullard Machine Tool Company, conceived the idea of placing one of the turrets on the vertical slide at the side of the column. This combination of vertical and horizontal rails and turret slides permitted the tools to be set for simultaneous cuts on any part of the work without interfering with each other. A machine was built to try out this idea, and later a number of them were installed in various plants, although they were not publicly put on sale. From time to time improvements and elaborations have been made until the machine has developed into its present form, which has been very properly called a "vertical turret lathe." It will be seen that the arrangement of the slides and tool-holders fits it for filling very nearly the field occupied by the heavy horizontal turret lathe, particularly in the matter of finishing castings and large diameter forgings.

The machine consists essentially of a rotating face-plate, mounted on a bed which has a vertical column carrying a horizontal turret slide at its right-hand side, and a cross rail with a vertical turret slide above the work. The ram or tool slide in the carriage on the vertical slide has a four-sided turret for holding turning and facing tools. The cross rail turret slide has a heavy hexagonal turret for boring, reaming, facing and turning tools. These two sets of tool-holders are provided with suitable feeds and handling devices as will be described.

The table is driven from an internal gear of nearly the outside diameter of the table. It is naturally self-centering, due to the large angular thrust bearing with which it is provided. The side strains are taken by straight vertical bearings of large proportions. The weight of the table spindle and work tends to preserve rather than destroy the alignment. The spindle journals are carefully scraped to fit, and are entirely immersed in oil.

A feature of the spindle drive mechanism is the fact that no step-up in the speeds is involved in the gearing, a constant reduction being maintained at all speeds, all the way from the driving pulley to the table.

The table has 15 changes of speed, obtained by a positive geared mechanism from a single speed pulley or electric motor. The controlling mechanism for these changes is planned on what the builders call the "automobile" principle, described in connection with their 56-inch "rapid production" boring mill in the December, 1905, issue of MACHINERY. The handle G may be given three positions corresponding to three changes of speed obtained by positive clutches in the head-stock B. Pilot wheel A has five positions corresponding to

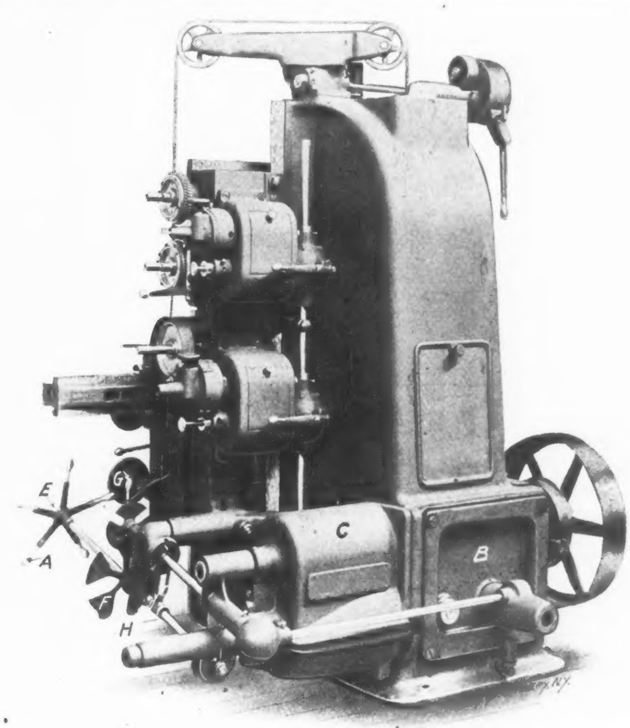


Fig. 2. Rear View of Vertical Turret Lathe, showing Spindle Speed Changing Device.

the five changes obtained in speed box C by a cone of gears and friction clutches. The raising of the shaft on which the pilot wheel is mounted, by handle E, throws a brake into action, for stopping the table at any desired point. The movements of E, A and G are interlocked by the locking disk F, the link H and the attached parts, in such a way that it is impossible for the workman to make an error in handling the controlling mechanism. The brake handle E cannot be raised until the pilot wheel A is placed in a neutral position, so that the power is cut off; and handle G, controlling the positive clutches, cannot be shifted until the mechanism is disconnected from the power and the brake applied. This

arrangment gives a "selective" control, making it possible to change from any speed to any other without going through the intermediate positions. The number of table revolutions per minute may be instantly ascertained from the direct reading indicator incorporated in the interlocking mechanism. The arrangement of the pilot wheel and its attached parts, the selective control, and the concentration of all operating levers within easy reach of the operator, account for the likeness to the mechanism of the automobile to which the builders refer.

The same facility for rapid changes is furnished for the various feeds, as has been described for the spindle speeds.

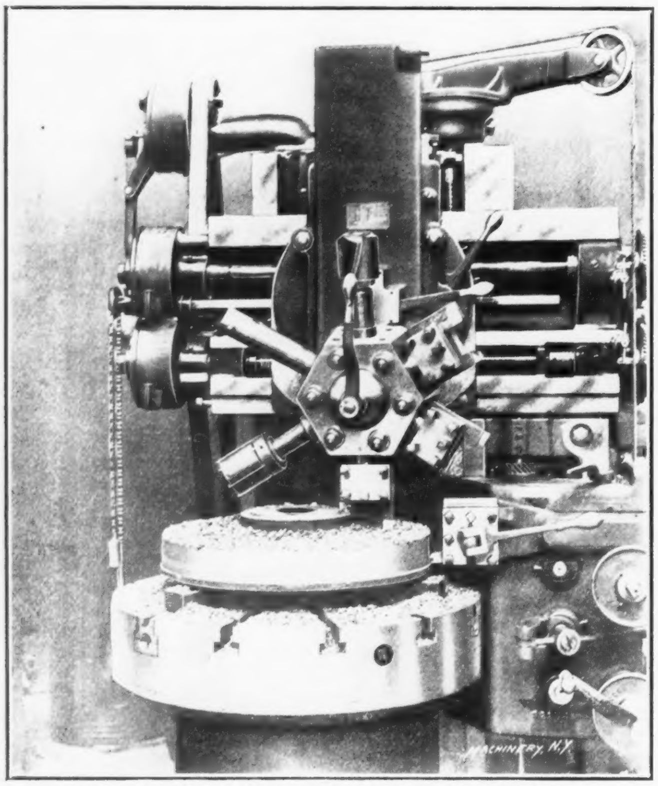


Fig. 3. Machine in Operation, Finishing Gear Blanks.

Each slide is provided with its own rapid feed change mechanism, handled by its own separate levers. The eight changes are obtained in two series of four by cones of gears constantly in mesh. Handles on each feed box are provided for shifting the position of the "diving" keys, to match the gears they are required to engage. It will be noted that there are no pull gears used in changing from cross to vertical feeds and vice versa. In the case of the cross rail, a drop worm is used which may be connected to the worm-wheel on either the cross feed or vertical feed shafts. In the case of the movements for the side head on the vertical slide, the change from cross to vertical feed is made by the lever shown between the two square-ended operating shafts. This lever controls friction clutches for throwing in either of the two feeds desired. The operating shafts on this side head are provided with disks having graduations for reading the movements in both directions, and similar graduations are provided on the worm-wheels operating the movements of the cross slide turret. Clips numbered to correspond with the holes in the two turrets are used at these two points. These clips may be set in any desired position, and used instead of stops for the various movements, obviating the necessity for all calipering and measuring except in the case of the first piece made. They have the advantage of greater accuracy, and are not subjected to some of the mechanical difficulties involved in the use of automatic throw-outs or positive stops.

Positive stops are provided for setting the turret slide accurately in a vertical position and for centering it for boring, drilling, reaming, etc.

A rapid power handling mechanism, operated from the driving shaft by a belt running to the small pulley and gearing shown at the extreme upper left hand corner of Fig. 1, may be used to operate all the movements of the main turret, or for raising and lowering the cross and vertical slides and all their attached mechanism. The cross and vertical slides move together as a unit. The two cross handles shown just at the left of the worm gears on the cross rail control the rapid power movements for that mechanism. A friction slip, set up strong enough to carry the heaviest feeds that are met with, but having the tension adjusted well within the limit of strength of the mechanism, is provided for each of the various feed movements, so that no damage to the machine will result from the attempt to run the slides beyond the limit of their travel, or from running them together so that they strike. The quick acting mechanism, being driven from the first speed shaft, has a constant rate, and has no relation to the speed of the table.

Fig. 4 shows the construction of the various friction clutches used throughout the machine. A bent lever, as shown, is arranged to expand an internal ring against the inner rim of the driving gear. The long end of this lever bears on the top of a plunger, which passes through the supporting sleeve to the hole in its center. Through this central hole passes a rod, flatted on one side, and carrying a wedge adapted to raise the plunger and throw in the clutch when it comes opposite to it. A series of clutches with their levers and plungers may be mounted on the sleeve, and this wedge brought to act on any one of them. Owing to the fact that the clutch lever has some degree of flexibility, the clutch is practically self-adjusting; but if, after long usage, it should be necessary to take up the friction on account of the wear it has suffered, the small wedge shown at the fulcrum point may be set up. Provision is made in the speed box construction whereby the adjusting points may be brought in line with a removable cap, so that it is unnecessary to take the machine apart for this purpose.

Fig. 3 shows the machine set up for a turning and facing operation on a gear blank. Its likeness to the horizontal turret lathe is at once evident, the shape of the tool-holders and the arrangement of the main turret being identical, although the vertical form of the machine renders necessary a general change in the outward appearance of the machine. This vertical turret lathe has, in fact, at least one advantage over its horizontal competitor, in the simplicity of the tool equipment required, owing to the fact that the main turret head on the cross rail has a full universal movement, both

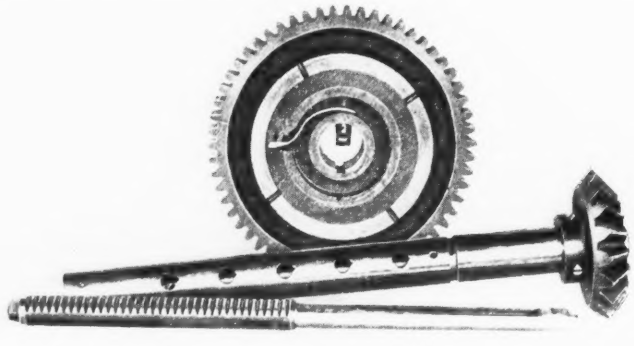


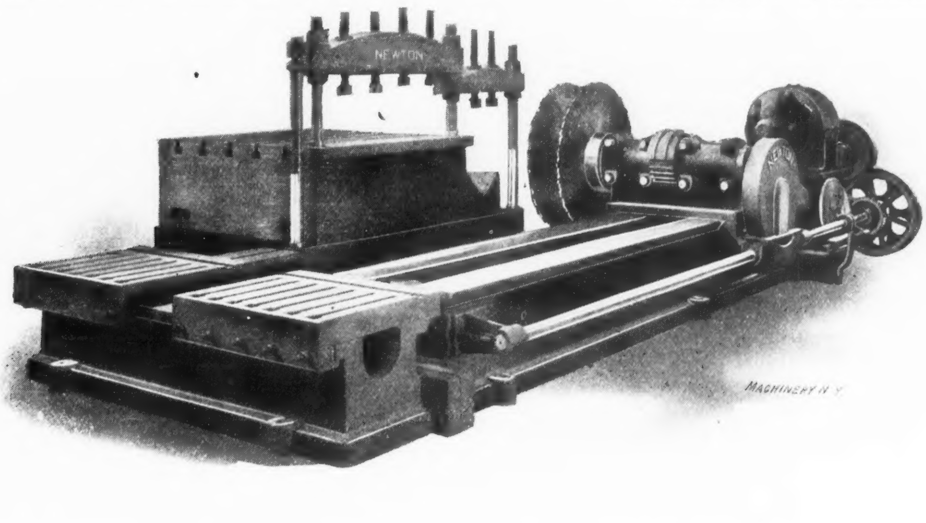
Fig. 4. Construction of Friction Clutch, generally used throughout the Machine.

vertical and horizontal, throughout the entire range of the machine, so that expensive overhanging cutters are unnecessary. This advantage is well illustrated in Fig. 3.

The machine has a capacity for work 36 inches in diameter and 24 inches in height. The face-plate, which is 34 inches in diameter, may be built plain with four independent jaws fitted to it; or, if desired, may be given the form of a three-jaw combination chuck or a four-jaw independent chuck. The main turret will face work 36 inches in diameter, and has a vertical movement of 26 inches. It may be swiveled to any angle up to 45 degrees, either side of the center. The turret is 12 inches in diameter, and bored for tool shanks $2\frac{1}{2}$ inches in diameter. The side head has a vertical movement of 28 inches, and a horizontal movement of 15 inches. $1 \times 1\frac{1}{4}$-inch tool steel may be used in the four-sided tool-holder. A thread cutting attachment for threads from 2 to 14 per inch may be furnished extra if desired, and can be applied at any time subsequent to the purchase of the machine. The net weight of the machine is about 11,300 pounds.

NEWTON DOUBLE COLD SAW CUTTING OFF MACHINE.

This tool, built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., is adapted to a wide range of work, owing to the construction of the work-holding tables and the provision made for carrying two saw blades when required. It was built for the Pennsylvania Railroad Co. for general locomotive work. In this service it may be used in cutting off round stock up to 11½ inches in diameter, for sawing off oblong sections up to 11½ x 38 inches long, or, with the double saws, for cutting out crank-shafts, connecting-rod ends, etc., to a depth of 11½ inches. Round stock is held in the V-block shown at the further end of the work table. General cutting-off work may be done on the supplementary table, shown with the clamping device attached. When using the two saws for cutting out rectangular openings, the adjustable tables at the front end of the machine are used for holding the work. These may be set as close together as the width of the opening required will allow, so that the work is supported close up to the saws.



Cold Saw with Double Blades for Cutting Out Connecting-rod Ends, Etc.

The saw spindle is driven by spur gearing, from a phosphor bronze worm-wheel and a hardened steel worm of steep lead, enclosed and run in oil, and geared to a 15-horse-power motor mounted on the end of the base. The saw carriage has an automatic feed movement with power quick return, the feed variation being obtained from friction disks running at high speed.

In a test carried out in the shops of the builders, cuts to a depth of 12 inches were made in locomotive rod ends with the blades set 5¾ inches apart. The rods were 5 inches thick, and the time taken for each cut was 17 minutes. This record the customers have been able to maintain, resulting in a saving of about 50 per cent over the time required by former methods of working out the open ends.

DRILL SPEED AND FEED AND DECIMAL EQUIVALENT INDICATOR.

The Cleveland Twist Drill Co., Cleveland, Ohio, has designed the neat drill speed and feed, and decimal equivalent indicator

Fig. 1. Decimal Equivalent Indicator (one-half size).

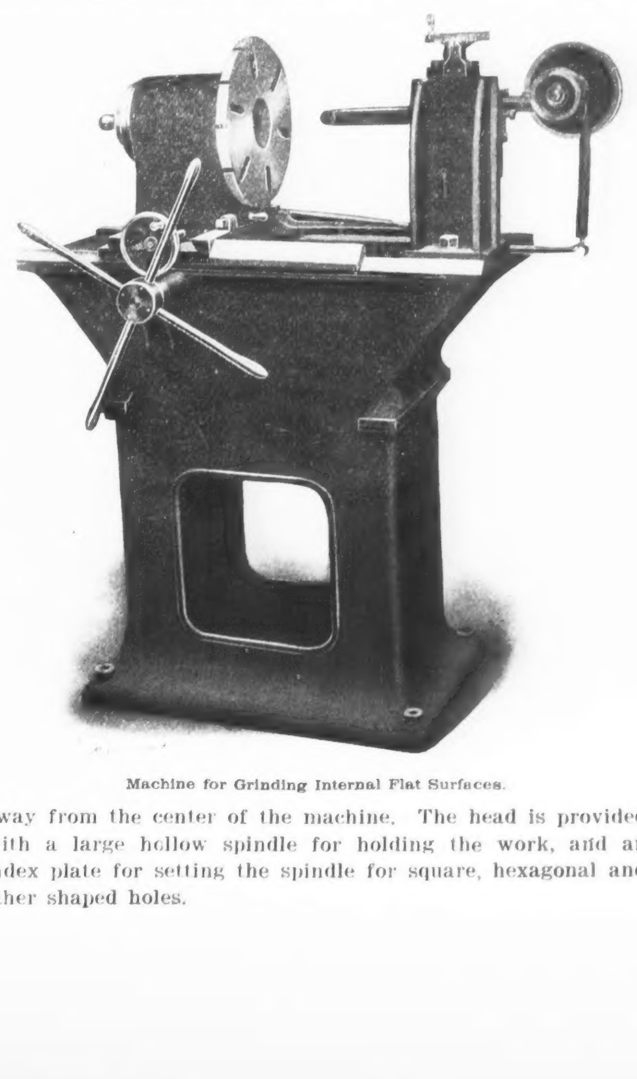
Fig. 2. Drill Speed and Feed Indicator (one-half size).

shown below. It consists of two celluloid disks pivoted on opposite sides of a third and larger celluloid disk. The outer disks are notched and the middle disk has concentric rows of numbers, as shown in the cuts. In the case of the drill speed and feed indicator, Fig. 2, the outer concentric row of numbers is the diameters of the drills. The second row, one number of which shows through the notch, is the proper speed in revolution per minute for carbon steel drills, and the inner row shows the revolutions per minute permissible with high-speed drills. Thus for a 2⅝-inch drill 43.7 revolutions per minute are indicated for carbon steel drills and 72.8 for high-speed steel drills. Good feed practice is stated in the paragraph on the face of the rotatable disk. The decimal equivalent indicator on the opposite side, Fig. 1, works on the same principle, the outer row of numbers being common fractions up to 1, varying by sixty-fourths, and the inner row the equivalents, to five places of decimals. The company will send these disks to all interested.

IMPROVED SQUARE HOLE GRINDING MACHINE.

In the February, 1907, issue of MACHINERY we published a description of a machine built by C. W. Burton, Griffiths & Co., Ludgate Square, Ludgate Hill, London, for grinding square, hexagonal and other flat-sided holes, such as are found in automobile work and other machinery. Ordinarily such holes are finished on the slotter or are broached. In automobile work, where parts subject to wear are generally hardened, the accuracy required necessitates finishing the surfaces of such small holes after hardening. The machine mentioned was designed to perform this difficult operation. The half-tone shows an improved design recently developed by the manufacturers, intended for general manufacturing.

The machine consists of a strong bed, provided with ways on which the work carrying carriage traverses by means of a rack and pinion operated by a hand-wheel. On cross ways on this carriage is mounted the work carrying head, which may thus be adjusted toward or



Machine for Grinding Internal Flat Surfaces.

away from the center of the machine. The head is provided with a large hollow spindle for holding the work, and an index plate for setting the spindle for square, hexagonal and other shaped holes.

The grinding wheel is of the cup form, and is carried on a bar which projects from a vertically adjustable slide on the knee, shown at the right of the bed. It is driven by an endless round belt running along the bar, connecting the wheel with the small speed multiplying counter-shaft attached to the vertical slide. This counter-shaft is supported by a hinged arm with spring tension, so as to prevent the vibration in the driving belt from affecting the bar carrying the emery wheel —a condition which would impair the accuracy of the work if not allowed for. The vertical slide is elevated by a screw, having a hand-wheel graduated to read in thousandths of an inch. This movement provides for broad surfacing by raising and lowering the emery wheel, in addition to the traversing movement of the carriage, given by the pilot wheel. The feed movements are operated by hand.

WHITCOMB-BLAISDELL 20-INCH LATHE.

The Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., has recently placed on the market the 20-inch lathe shown in the accompanying half-tones. This lathe is intended to possess the required driving power at high speeds

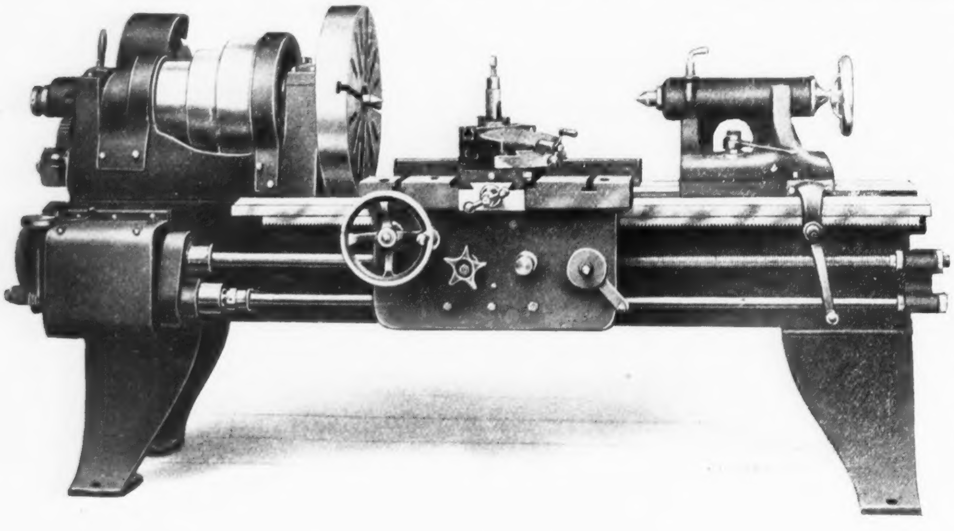


Fig. 1. Whitcomb-Blaisdell 20-inch Lathe.

for using modern tool steels, and at the same time to be easily handled in all its movements, so as to reduce to a minimum the time between cuts.

The bed of the lathe is substantial and well proportioned, being stiffly ribbed and of the box pattern type, with a broad top carrying ways of generous proportions. Fig. 3 shows the headstock with the gear guards removed. A 3-step cone of large diameter and wide face is used. This, in conjunction with

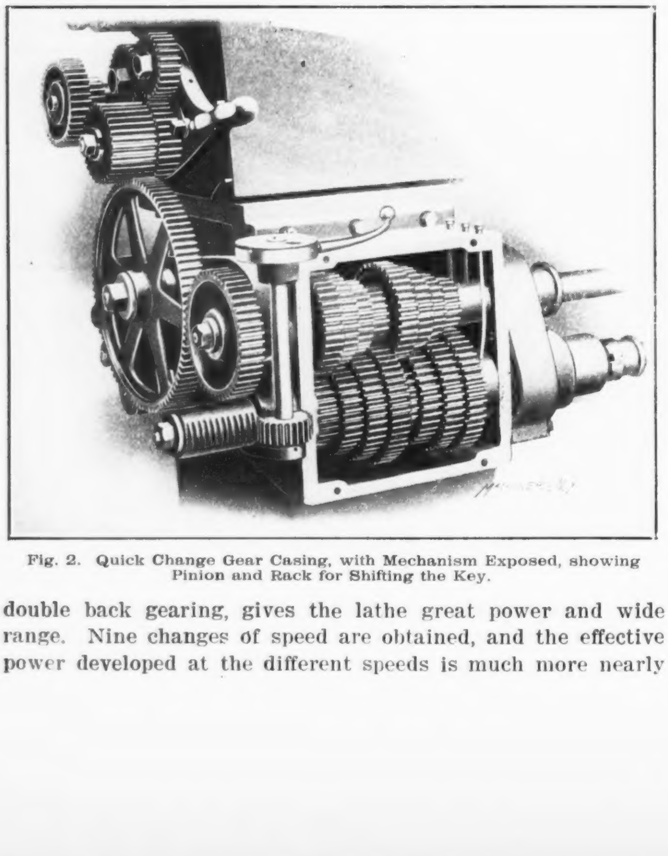


Fig. 2. Quick Change Gear Casing, with Mechanism Exposed, showing Pinion and Rack for Shifting the Key.

double back gearing, gives the lathe great power and wide range. Nine changes of speed are obtained, and the effective power developed at the different speeds is much more nearly equal than is the case when the same range is obtained with single back gearing and a cone having four or five steps.

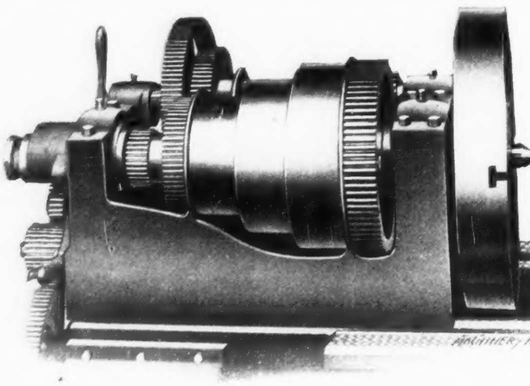


Fig. 3. Head-stock, with Guard Removed, showing Gearing.

The smallest diameter of the cone of this lathe is so proportioned as to give ample belt contact and speed. The spindle is of high carbon crucible steel with generous journals, running in bronze boxes.

A quick change device for feeds has been applied. This is best shown in Fig. 2. It is simple and durable in design, and well made. It consists, as shown, of two parallel shafts carrying eight gears each, meshing with each other. The gears on the lower shaft run freely on it, but may be connected to it by a sliding key, operated by the handle through the rack and pinion shown. This gives the operator command of eight geared feeds, or eight of the commonly used screw pitches. Then, by bringing into use a small compound gear permanently placed at the end of the head-stock, eight more feeds and screw pitches are obtained. All this is done without the removal of a gear. Three extra changes are provided, however, one of them solely for the purpose of permitting 11½ threads per inch to be cut, and the other two to double the range of both the feed and the screw pitch numbers.

The apron of this lathe is of substantial design and carries a feed mechanism of great strength and durability. The gears

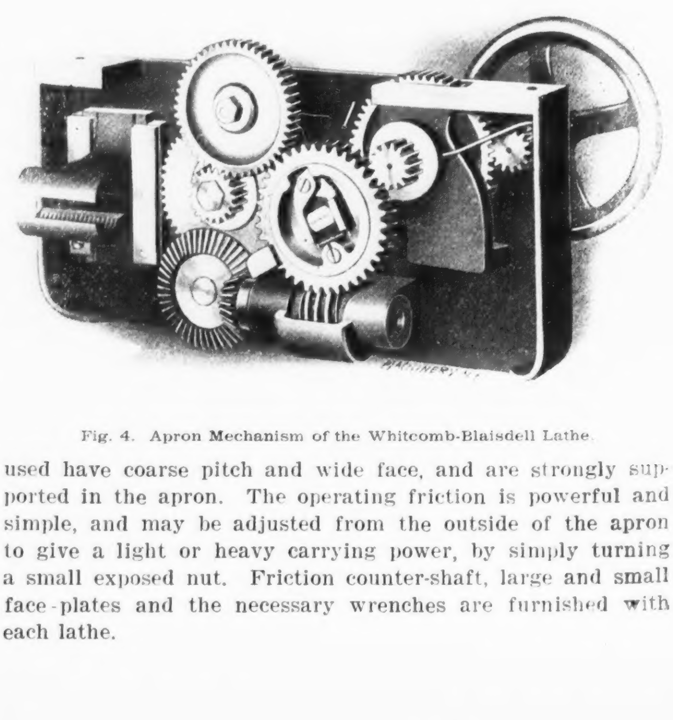


Fig. 4. Apron Mechanism of the Whitcomb-Blaisdell Lathe.

used have coarse pitch and wide face, and are strongly supported in the apron. The operating friction is powerful and simple, and may be adjusted from the outside of the apron to give a light or heavy carrying power, by simply turning a small exposed nut. Friction counter-shaft, large and small face-plates and the necessary wrenches are furnished with each lathe.

PEASE BLUE-PRINT CUTTING, TRIMMING AND SIZING TABLE.

The apparatus shown in the accompanying cut is made and sold by C. F. Pease Blue-print Machinery & Supply Company of 22 Fifth Avenue, Chicago. It is designed to facilitate the cutting to size of blue-prints, or of unexposed blue-print paper. The cutting or trimming table is constructed of hardwood with metal trimmings, and is so arranged as to be easily knocked down for shipment. The top of this table is covered with a sizing diagram, which gives at a glance the dimensions of the tracing or print being trimmed or cut, and the area in square feet, no calculation being necessary. The top of the table is 4 feet wide by 6 feet long. The cutting

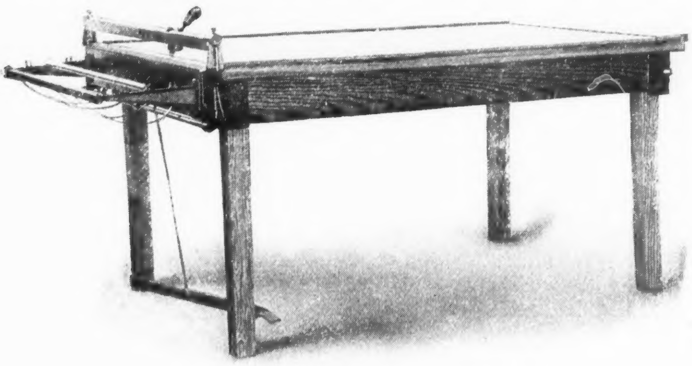


Table with Attachment for Sizing and Trimming Blue-prints.

and trimming device at the end is provided with a parallel clamp, operated by the treadle shown, which holds the paper or print securely while the knife is being used. The cutting knife is of the revolving type, rotating positively by mechanical means, not depending on the friction caused by the blade on the paper. Owing to this construction it will cut a narrow strip of the thinnest paper with rapidity and precision. The apparatus was designed especially for cutting up blue-prints exposed on the builders' continuous printing machine. It will cut accurately to a line, trimming the print perfectly at the same time it is cut from the roll.

* * *

It is reported that the White Star Line proposes to equip a passenger steamer on their Dominion Line with a combination of turbines and reciprocating engines. This steamer is to be built by Harland & Wolff. This combination has been advocated by Mr. Parsons for some time in the case of vessels of moderate or slow speed, from the point of fuel economy. It is proposed to use the turbines for the low-pressure expansion. A considerable gain in economy is expected with this arrangement, since the turbines are able to carry the expansion of steam economically to a degree far beyond that obtainable in the cylinder of the reciprocating engine. It will be necessary to provide for the use of condensers permitting a high vacuum. A gain of from 10 to 12 per cent is claimed in consequence. The proposal of Messrs. Harland & Wolff is to use two sets of quadruple expansion engines, each driving a screw propeller and placed in about the position they would occupy in a twin-screw steamer. Associated with them on a central shaft, a single turbine is to be used, driving a third propeller of a smaller diameter than the wing screws driven by reciprocating engines. This is only one of two or three arrangements which have been proposed, the problem being a more or less uncertain one as yet.

* * *

The machinists who hire out to go to the Panama Canal are required to provide the following extensive (?) list of tools: One pair each 8-inch inside and outside calipers; one 2-foot rule; 1 combination square; and one 4-inch or 6-inch steel scale. Car borers and axle turners are required to have one pair 8-inch inside calipers; one pair 8-inch outside calipers, and one 2-foot rule. Surely the eminent Isthmian Canal Commission should have included in the latter case that essential little tool required for making infallible press fits—the prick-punch.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE CONDITIONS.

Steady business seems to be the characteristic feature of British trade in general, the amounts and values dealt with in the returns tending to increase. For the month of July the value of British exports increased by $35,000,000 or 20 per cent as compared with the same period in 1906, and the imports increased by $16,500,000. For the seven months ending July, the increased value of exports was $163,665,000, and the imports $157,140,000. The total values of the exports and imports for the same period were $1,528,536,735 and $1,900,000,000, respectively. Simultaneously with these developments the prices obtainable for bonds and railway stocks of the best descriptions have steadily depreciated, a feature not confined to this country. The much better rate of interest now obtainable from many industrial investments is advanced as one reason for the decline, but the situation has not yet been convincingly accounted for.

Labor Conditions and Supply.

In labor matters a noticeable feature has been the number of minor strikes of comparatively isolated character and dealing with local issues. A local strike of shipbuilders at Newcastle, in which the men left work in an irregular manner, has resulted in the Employers' Federation taking advantage of the incident to threaten a lock-out on a large scale, until machinery has been set up to allow of negotiation proceeding in every case of dispute, without stoppages being occasioned. In Belfast, however, a strike of carters and dockyard laborers for an increase of wages with reduction of hours, and also for the recognition of the union officials as responsible negotiators on the men's behalf, developed in a serious manner. Disturbances and riots principally participated in, with no definite object, by outsiders, culminated in armed force having to be resorted to with some loss of life. Government action in the way of conciliation had to be undertaken and with the personal efforts of local priests and magistrates and prominent government officials, a provisional settlement was arrived at by which wages were increased and hours reduced but no present concessions granted as regards recognition of union officials. This latter point is, however, being brought into considerable prominence by railway employes who consider it of even more importance than immediate questions of wages and hours. Considerable pressure has recently been brought to bear, with some success, on non-unionists, particularly in the coal and cotton trades, to induce them to join the trade unions. Whether such action is inimical to general progress is open to discussion. In connection with the new Workmen's Compensation Act, recently brought into operation, which greatly increases the number of work people entitled to benefit in case of accident, the services of many elderly men have been dispensed with in view of their assumed greater liability to meet with accidents. It has been proposed to make the insuring of risks compulsory on the part of the employer, somewhat on lines now in vogue in Germany.

American concerns are often exercised as to the future supply of labor, but the offering of prizes at agricultural shows for the largest working families is a method most probably untried. Over here, in the almost purely agricultural county of Lincolnshire, the leading agricultural society annually offers prizes for the largest families who have been brought up and placed in agricultural service. The first prize this year was awarded for a family numbering nineteen children, of whom fourteen had been brought up and placed in work. The second prize went to a family which had numbered twenty-three, of whom seventeen had been brought up and twelve placed. President Roosevelt would scarcely recognize symptoms of race suicide in Lincolnshire.

New Discoveries of Coal and Iron.

Periodical scares arise as to the future supplies of coal and iron, pessimistic tendencies nearly always prevailing. However, at the present time new deposits of iron ore are reported in the north of Ireland, Staffordshire, Derbyshire, Cumberland, Lancashire, and Sussex. In the latter county

coal for smelting purposes is not at present available, the ore having to be shipped to the north for smelting, but boreholes are being sunk with some prospects of coal being found, and somewhat more optimistic views on the topic generally find expression.

Shipbuilding Developments.

Touching on shipbuilding matters, the trial performances of the *Lusitania* have evoked great interest, particularly the 48 hours run over a course of 300 miles under conditions representing average Atlantic conditions, when the contract speed of 24½ knots was exceeded by a margin of three-quarters of a knot. To the present time, its design, construction, launching and performances have been a continuous series of triumphs. In the naval section, the *Bellerophon*, recently launched at Portsmouth, less than eight months after the laying down of the keel, represents an increased displacement over the *Dreadnought* of about 700 tons. The length and beam of the new vessel are 496 feet and 82 feet, respectively. Turbine engines to develop 23,000 horse-power will be fitted, giving a speed of 20¾ knots. Her armament will include ten 12-inch guns, with four 7-inch guns for repelling torpedo attacks. The total cost will be about $10,000,000.

Harland & Wolff are understood to purpose utilizing a combination of reciprocating and turbine engines in a new Atlantic liner to be laid down, and the departure will be closely followed in view of the possibilities in the way of economies in steam consumption, increased maneuvering facilities and decreased first cost. In connection with the maintenance and deepening of the Mersey channel at Liverpool, three of the largest dredgers yet built are employed, but a still more powerful one is to be added, capable of lifting 1,000 tons of sand in 50 minutes from a maximum depth of 70 feet.

The proposal of the Canadian Government to construct a ship canal with a navigable depth of 24 feet, connecting the Great Lakes *via* the St. Lawrence and Montreal with Liverpool, and perhaps Manchester, by the establishment of a special line of steamers, will, if proceeded with, involve an expenditure of $100,000,000. The firm of C. H. Walker & Co., of London, who were the engineering contractors for the construction of the Manchester to Liverpool ship canal, is freely mentioned as likely to be instrumental in the carrying out of the work.

Olympia Machinery Exhibition.

The Engineering and Machine Tool Exhibition to be held at Olympia, London, during September and October is being participated in by a larger number of representative British tool makers than that of last year. One reason for the smaller representation then was the lack of tools to show, as deliveries were often many months behind. The leading tool merchants contrived to make a good show, Continental specialties being well in evidence, and generally the exhibition was so successful from a business standpoint that special efforts have this year been made to secure good locations and place the latest productions on view.

Machines for General Purposes in Demand.

Concurrently with the general appreciation and employment of special machine tools, particularly in the line of turret lathes and automatics, is to be noted a disposition to concede cheerful recognition of the possibilities of comparatively simple, but well made tools which combine ample power with some extra facilities for all-round work. This is particularly the case where, though a good aggregate of work is dealt with, the demand for any one article is somewhat irregular, and the ability to employ the machine regularly at a medium profit on any miscellaneous work is of greater importance than the possibilities of mass production, at very low labor costs, of an expensive machine which could only be intermittently employed. Of late years the Glasgow district has become more prominent in the line of machine tool manufacture.

For some time heavy machine tools have been produced in good quantity, chiefly in connection with shipbuilding and marine and locomotive engineering, but medium and light tools were not so systematically built and brought to the notice of users. The industry in these branches now seems likely to increase, the recent shortage of American tools having no doubt assisted in the upward movement.

Shanks & Co., Ltd., of Johnstone, in its more recent commercial literature enters more fully than is usually the case into the reasons for the distinctive features embodied in its designs.

Slotting and shaping machines appear to hold their own with increasing tenacity notwithstanding the competition of improved types of milling machines, and a statement of Messrs. Shanks on the rate of machining plane surfaces on a 20-inch stroke traverse head shaper is of interest, it being to the effect that 30 square inches per minute may be machined with heavy cuts.

New Grinding Machines.

Macdonald, Adamson, Swinburne & Co., Ltd., of Barrhead, near Glasgow, is one of the latest additions to British manufacturers of precision grinding machinery. Its universal machines are driven by motor or direct from the line shafts, no overhead gear being employed. The speeds of the headstocks, traverse, and emery wheel drives are all separately adjustable by the finest gradations, and controlled by individual lever in front of the machine. Another line taken up by the company is the manufacture of disk-grinding machines in a variety of designs and capacities. With regard to the employment of grinding machines in general, the necessity for frank collaboration between the builders and users of the machines and the makers of the abrading wheels, in the selection of suitable grades, etc., of wheels, and the methods adopted in their employment is much more generally assented to than formerly, an attitude conducive to even more striking and satisfactory results than has already attended this form of machining surfaces.

JAMES VOSE.

Manchester, England, August 24, 1907.

MISCELLANEOUS FOREIGN NOTES.

INTERNATIONAL EXHIBITION IN TOKIO.—The Japanese government has allowed $5,000,000 for an international exhibition to be held in Tokio next year. The total cost is estimated to be $10,000,000, half of which has already been subscribed for by private citizens. The exhibition will open on April 1 and will last until October 15, and it is intended to make it the greatest exhibit that has ever taken place outside of Europe and the United States.

ENCOURAGEMENT OF INDUSTRY IN MEXICO.—An agreement has been entered into between the Mexican government and some industrial promoters for the establishment within the territory of Mexico of a factory or factories for the manufacture of engines and motors. The capital invested in the business is to be exempt for a period of ten years from the date of the contract from all direct Federal taxes, with the exception of the stamp tax. All the necessary material and machinery may be imported free of duty.

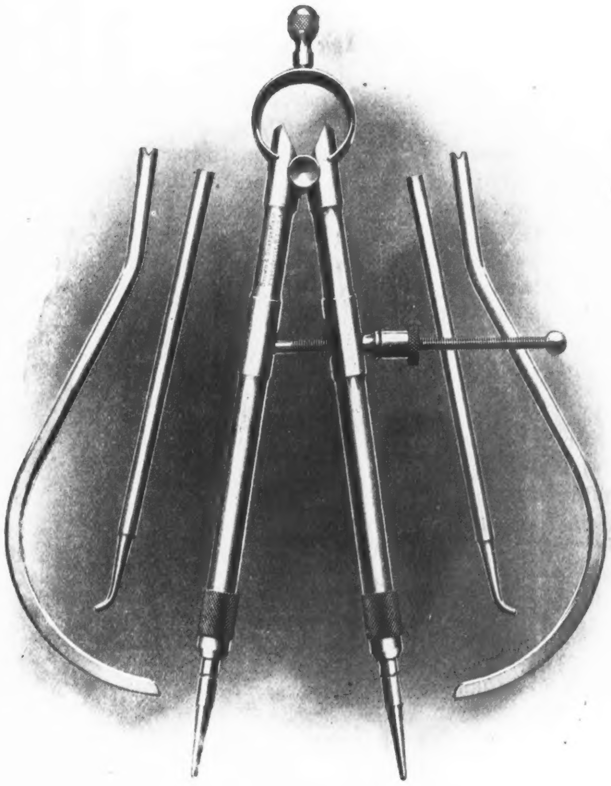
SPECIALIZED GERMAN EXHIBITIONS.—We mentioned in our September issue the tendency in Germany to discourage world's fairs, and instead favor small exhibitions of certain branches of industries. A general exhibition of inventions for use in the minor industries has been in progress in Berlin this summer. It was held as a preliminary to a larger exhibition to be held later in the same city, and for the purpose of stimulating invention and "enlarging and multiplying the points of contact between inventor and capitalist, designer and manufacturer, producer and customer."

PROGRESS IN THE AUTOMOBILE BUSINESS IN GERMANY.—The automobile business in Germany seems to be not only in a flourishing state as far as production is concerned, but to be a well-paying business as well. The well-known German automobile firm, Benz & Co., reports for 1906 earnings amounting to nearly $300,000, and declares a dividend of 15 per cent. In 1905 the firm paid 7 per cent. In view of the recent failures of some American automobile concerns, these results are the more remarkable. It is likely, however, that the German firm has not capitalized "good will" at quite as high a figure as have some of our concerns.

Brown & Sharpe Mfg. Co.

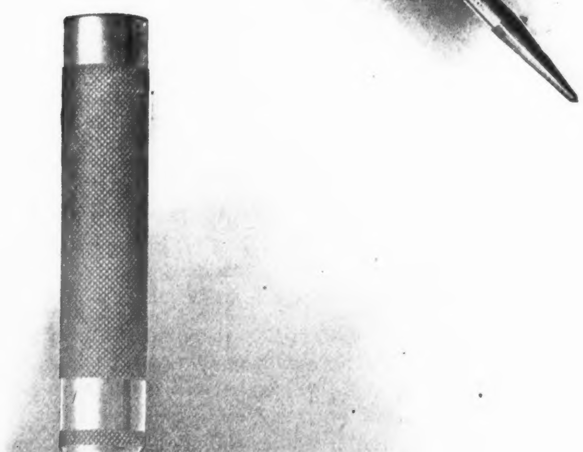
PROVIDENCE, RHODE ISLAND, U. S. A.

We are constantly adding new tools that the machinist may be more thoroughly equipped for all varieties of work.



Combination Caliper and Divider.

Pocket Automatic Center Punch.



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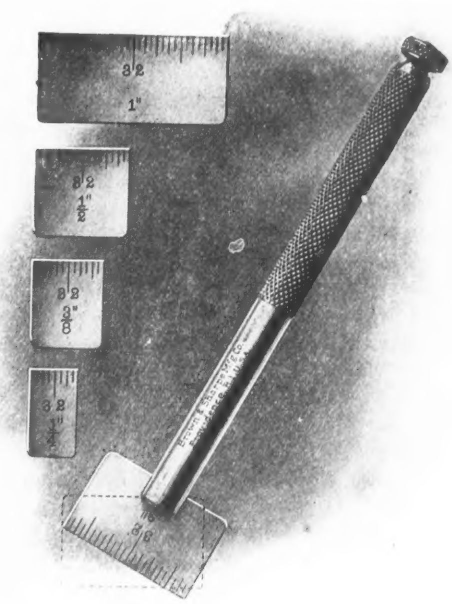


Steel Rules with Holder.

WRITE FOR THE NEW TOOL CIRCULAR DESCRIBING THEM.

GERMAN MACHINERY EXPORTS.—The machinery exports from Germany have been steadily increasing during the first part of the present year. Comparing the figures for the month of April in 1906 and in 1907 we find that the exports of machine tools last year in that month were 1,783 tons, as compared with 3,551 tons this year. It is, however, considered that the German trade and industry at the present time has attained what might be called the high-water mark in the economic development of the German nation. The new commercial treaties with foreign countries are not entirely favorable to many German industries, and the result of their workings can not fail to show itself in the future, even if it has not done so as yet. Since the establishment of these treaties, it has been noticed that German industries heretofore restricted entirely to Germany have established themselves beyond the boundaries of the empire. It is reported that there is some anxiety among manufacturers that the prices of raw material will increase to such an extent as to put a check on the increase of the consumption of the products of German industries. To what extent these fears are founded on reasonable ground is difficult to say.

* * *

THE LUSITANIA.

The new Cunard turbine steamer *Lusitania* sailed from Liverpool September 7 and arrived in New York harbor on the morning of September 13. She touched at Queenstown, and the elapsed time from Daunt's Rock to Sandy Hook was 5 days 54 minutes. It had been freely predicted that the new vessel would be a four-day boat, that is, one that would make a trans-Atlantic trip from Queenstown to New York in less than five days. While she failed to establish this record, she made a remarkable trip, and demonstrated her ability to cross in less than five days; conditions favorable.

An article describing the principal features of the *Lusitania* was published in the August, 1906, issue to which the reader is referred. We may briefly recapitulate the principal data which are as follows: Length, 785 feet; breadth, 88 feet; depth of hull, 60½ feet; displacement, with cargo, 45,000 tons; high-pressure turbines, 2; low-pressure turbines, 2; backing turbine on low pressure turbine shaft, 2; horse-power, 68,000 to 70,000; Scotch boilers, 25; stacks, 4; elliptical section, largest diameter, 24 feet; height from keel, 155 feet; steam pressure, 200 pounds; coal consumption, 1,000 to 1,100 tons per day; water-tight compartments, 175; draft, 33½ ft.; nominal speed, 25 knots; average time on first trip, 23.01 knots; first-class passengers, 540; second-class, 460; third-class, 1,200; crew, 800; builder, John Brown & Co., Clydebank.

The cabin appointments are in the highest degree luxurious, and the drawing rooms compare favorably with those of any first-class hotel in spaciousness and general appointments. One detail worth mentioning is open fire-places with flues (not make-believe affairs) which form prominent features of the first-class drawing room appointments. The toilets and bathrooms have tiled floors, and in other ways the resemblance to the superior accommodations of high-grade hotels is very marked. In fact, it has been aptly said that the *Lusitania* is more like an immense floating hotel than a ship, because of the steadiness of motion and freedom from vibration, due largely to the use of turbines instead of reciprocating engines.

On Tuesday, September 17, representatives of the press were entertained at luncheon in the gorgeous first-class dining rooms. The inspection of the vessel was disappointing to many, as admission was denied to the engine rooms. The reason for this action on the part of the officials was not apparent, but the probability is that the trip has developed a number of minor defects which required the constant attention of the engine-room force during the stay in port to correct, hence the natural indisposition to admit a critical body of men to the engine room while these minor repairs were being made.

The Cunard Co. is building a still larger vessel, the *Mauretania*, which is 790 feet long, to act as a sister ship to the *Lusitania*. The *Mauretania* at the time of writing this note had just started on her trial trip. Both vessels were built under a subsidy grant and will be made transports or commerce-destroyers in time of war. Gun platforms have been provided, and the partitions in the third-class sections have been designed so as to be readily removed, as would be necessary when transporting large bodies of troops.

* * *

The annual convention of the National Machine Tool Builders' Association will be held in New York City, Tuesday and Wednesday, October 15 and 16. The Hotel Imperial, corner Broadway and 32d St., has been selected as headquarters. Further information may be obtained from the secretary, Mr. P. E. Montanus, of the Springfield Machine Tool Co., Springfield, Ohio.

* * *

Foreign letter postage rates were reduced, beginning October 1. The new rates, which were agreed upon at the Universal Postal Union at Rome in May, 1906, are less than those heretofore obtaining by 50 per cent or more. Instead of a rate of 5 cents per each half ounce of weight, as was formerly the case, the rate is now 5 cents for the first ounce and 3 cents for each additional ounce.

* * *

OBITUARY.

Robert A. Brown, president of the New Haven Mfg. Co., New Haven, Conn., died September 22. He was born in 1835, and was nearly 72 years old. He had been connected with the New Haven Mfg. Co. for 52 years, and had held the office of president of the company for the past 31 years. Mr. Brown also was interested in other industrial concerns and in banks and banking interests.

Walter Scott, inventor and builder of printing presses, died at his home in Plainfield, N. J., September 14. Mr. Scott was born in Scotland in 1844. He emigrated to America in 1869 and settled in Chicago, where he remained about fifteen years. In 1884 he moved from Chicago to Plainfield, and later erected the large Walter Scott Printing Press Co.'s Works. It is said that Mr. Scott had been granted more patents on printing press machinery that any other individual or concern in this line.

* * *

PERSONAL.

John Edgar has resigned his position as chief draftsman and designer of the Becker-Brainard Milling Machine Co., Hyde Park, Mass., where he has been employed for the past eight years, to develop new designs of milling machines.

Prof. W. F. M. Goss, for the past 28 years connected with the Purdue University, Lafayette, Ill., being in the later years dean of the School of Engineering, has resigned to accept the deanship of the Engineering Schools, University of Illinois.

C. Dickens Sternfels has resigned his position as publicity manager of the Arthur Koppel Co., Pittsburg, Pa., where he has been for the past three years, to assume charge of the newly organized publicity department of the Standard Roller Bearing Co., Philadelphia, Pa.

Francis Fenwick, of Fenwick Freres & Co., Paris, has been decorated with the cross of the Legion of Honor by the French Government in consideration of important contracts of machinery that his firm executed for the French Arsenal during recent years.

W. H. Booth, well known British engineer and writer, who has been in America several months, sailed for England, September 11, on the steamer *Adriatic*. Mr. Booth came to this country to dispose of certain English patents. He has returned with a number of American patents which he hopes to place abroad. Mr. Booth's London address is 2 Queen Anne's Gate, Westminster, S. W., London, England.

E. F. Needham has been appointed locomotive and car department superintendent of the Wabash R. R. to succeed Mr. J. B. Barnes, retired. Mr. Needham commenced work with the Wabash R. R. in 1880 as an apprentice at the Fort Wayne shops, and was promoted to foreman at Fort Wayne in 1894. He worked up to the position of master mechanic of the Eastern Division in 1902 and was made master mechanic of the Decatur and Springfield Division in 1906.

NEW BOOKS AND PAMPHLETS.

ON THE ART OF CUTTING METALS. By Fred W. Taylor. The presidential address presented at the December, 1906, meeting of the American Society of Mechanical Engineers has been reprinted and bound in cloth for general distribution. The price is $3.00.

This is the paper that was reprinted in abstract in MACHINERY, January to August, 1907, inclusive. This paper, or any other publication of the A. S. M. E., may be obtained by addressing the secretary, 29 West Thirty-ninth St., New York. It is not necessary to send orders through members, and none of the publications are copyrighted. A list of prices of the various publications may be obtained upon application.

BULLETIN NO. 13: An Explanation of the Dewey Decimal System of Classification, Applied to Architecture and Building. By N. Clifford Ricker. 102 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

The Dewey decimal system was invented and introduced by Dr. Melvil Dewey for classification of books and literary material, and has come into general use. The present bulletin, which is No. 13 of a series published by the Engineering Experiment Station of the University of Illinois, has been made for the convenience of architects, builders and engineers and others concerned with architecture and building. The scope and flexibility of the Dewey system is indicated by the fact that it is so readily applied to all branches of literature and ramifications of same.

THE APPLICATION OF SUPERHEATED STEAM TO LOCOMOTIVES, with special reference to the system invented by Wilhelm Schmidt, Wilhelmshohe, near Cassel, Germany. 40 pages, 9½ x 12 inches, illustrated with numerous examples of locomotives equipped with the Schmidt superheater system, and details of same. Five folding plates showing side elevation, plan and cross-section of locomotives so equipped. Published by the inventor.

This elegant pamphlet gives a short history of the application of superheated steam to locomotives and describes in detail the Schmidt system which has been so successfully developed in Europe and America. At the present time there are 2,315 locomotives in service or in the course of construction using this system.

GAS AND OIL ENGINES AND GAS PRODUCERS. By Lionel S. Marks and Samuel S. Wyer. 143 pages, 6½ x 9½ inches. Illustrated. Published by the American School of Correspondence, Chicago, Ill. Price $1.00.

Part I, by Prof. Marks, treats of the development of the internal combustion motor, giving a concise review of gas, gasoline, and oil engines, thermodynamics of the Otto cycle, operation and maintenance, etc. Part II, on gas producers, is treated by Prof. Wyer, and is divided in two parts, the first being a discussion of various gaseous fuels, and the second the manufacture of producer gas, giving details of various types of gas producers and principles of operation. The book can be recommended to all who wish to acquaint themselves with the present status of a power development that seems destined to largely displace the steam engine.

THE HANDELSHOCHSCHULE. 12 pages, 5 x 7 inches. Published by the Berlin Merchants' Association, Berlin, Germany.

This pamphlet was originally prepared for the British editors visiting Berlin in May, 1907, and has been reprinted for general distribution. It describes a sort of commercial university founded and organized by the Berlin Merchants' Corporation. The approved course of attendance to this school extends over a period of only two years. The curriculum includes the so-called commercial sciences—bookkeeping and accounting—political economy, insurance, law, geography, history, natural science, foreign languages; in short, a general education that is required to round out the education of a commercial man. The school occupies a new building erected at an expense of about $875,000 near the Berlin Bourse. Further information can be obtained from the Rector of the Handelshochschule, Spandauerstrasse 1, Berlin C, Germany.

PEAT: ITS USE AND MANUFACTURE. By Philip R. Björling and Frederick T. Gissing. 173 pages, 5 x 6¾ inches. 60 illustrations. Published by Charles Griffin & Co., London, and J. B. Lippincott & Co., Philadelphia.

Peat is found in great deposits in almost all countries, and its high calorific value when dry doubtless will make it a prominent fuel of the future (if not of the present) when the existing coal supplies have been so generally worked to low levels that the cost of mining is raised to a prohibitive figure. Peat has been used as domestic fuel from times immemorial, and its importance has been generally recognized, but its bulk, entrained water and lack of cohesion are difficulties in the way of utilization that have generally barred it from competing with coal so far, save in favored sections. Improvements in machinery and methods of treatment have been carried out in late years which promise that peat may soon come to be a common fuel in many districts more or less remote from cheap coal supply. The book in review treats of the formation, growth and distribution of peat; specific gravity and analyses; methods of digging, cutting and dredging; drying; peat fuel manufacture; nature and use of peat as a fuel; use of peat otherwise than a fuel; bibliography, list of patents, etc.

GRINDING AND LAPPING. By Joseph V. Woodworth. 162 pages. 6 x 9 inches, 137 cuts. Published by the Hill Publishing Co., New York. Price $2.00.

This interesting and valuable work is intended to be a practical treatise and reference book for tool-makers, on precision grinding and grinding processes, the preparation and use of abrasives, the construction and use of laps, etc. The author has drawn liberally on the experience of others and gives credit to various contributors in the *American Machinist* and MACHINERY for hints, suggestions and matters which have been freely used in the work. The work by chapters is as follows: Grinding; Conditions, Rules, Methods, Processes, Machines and Attachments for Accurate Grinding; Use and Preparation of Abrasives; Laps and Lapping; Construction and Use of Tools and Processes for Finishing Gages, Tools, Dies and Machine Parts to Accurate Dimensions; Construction, Use and Operation of Grinding Fixtures and Jigs, for Finishing Repetition and Articles of Metal, Small Hardened and Tempered Steel Parts and Special Work; The Hardening and Tempering of Interchangeable Tool Steel Parts of Delicate Structure which Require to be Ground and Lapped Afterwards; Percentage of Carbon Crucible Steel Parts and Tools Should Contain, Temper Colors to which They Should be Drawn, and Degrees of Heat for Giving Them Proper Tempers. The book is an example of technical literature of the specific order. Actual tools and methods are illustrated and described without dilating particularly upon the principles, the reader being left to draw his own inferences largely, and to adapt the principles to his own work.

CATALOGUES AND CIRCULARS.

THE JEFFREY MFG. CO., Columbus, O. Catalogue 69A, illustrating the various types of Jeffrey standard and special screens.

STANDARD GAGE STEEL CO., Beaver Falls, Pa. Catalogue of finished steel specialties, machine keys, elevator guides, special shapes, compression shaft couplings, screws and worms, finished machine racks, etc.

JOHN F. ALLEN, 370 Grand Ave., New York. Catalogue of portable pneumatic percussion and compression riveting machines for structural work, bridge building and boiler making.

CHARLES H. BESLY & CO., 15-17-19-21 South Clinton St., Chicago, Ill., has issued a booklet on Helmet oil. It tells how this oil may be used by automobilists, farmers, engineers, and machine shops, and for elevators, mining cars, motor boats, wagons, bicycles, etc.

THE CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Handy price list of drills, reamers, sockets, etc., made up in the form of a wall card for convenience of tool-room use. One side carries a list of drills and sockets, and the other of reamers and arbors.

NEW PROCESS TWIST DRILL CO., Taunton, Mass. Catalogues on hot forged twist drills and hot forged high speed twist drills, containing illustrations and specifications of these drills, drill lists for machine screw taps, tables of tap drills, speed of drills, etc.

THE L. S. STARRETT CO., Athol, Mass. Catalogue No. 18, containing price lists and specifications of steel rules, straight edges, tapes, squares, micrometers, hack saws, and other machinists' and draftsmen's tools.

CELFOR TOOL CO., formerly Geo. R. Rich Mfg. Co., 207 Railway Exchange, Chicago, Ill., has issued a bulletin describing the Celfor twist drills and chucks, and process of making, and showing this drill at work drilling forged connecting-rods, 8 inches thick, at the shops of the Allis-Chalmers Co., Milwaukee.

JONES & LAUGHLIN STEEL CO., Pittsburg, Pa. List and diagrams of structural shapes in Bessemer and open-hearth steel. This handbook contains 204 pages, 4 x 6¾ inches, and is bound in black flexible leather. It contains many of the usual data given in structural steel handbooks in regard to weights, shapes, permissible loads, manufacturers' standard specifications, useful tables, etc.

GUARANTEE ELECTRIC CO., Chicago, Ill. Chart of the Diseases of Dynamos, containing the same information as the chart "Diseases of Dynamos and Motors," issued with the September, 1906, issue of MACHINERY. This chart is printed with white ink on black paper, and is of very striking appearance. The sheet is about 17 x 25 inches, and is intended to be framed.

DREXEL INSTITUTE, Philadelphia, has sent an announcement of the evening classes in electrical, mechanical and civil engineering. The class in engineering subjects will meet two evenings per week throughout the session from October 1 to March 31. The fee for any class does not exceed $10. Further information may be obtained by addressing the director, Mr. Arthur J. Rowland.

WILLIAM H. BRISTOL, 45 Vesey St., New York City. Catalogue No 17 on electric pyrometers for indicating, recording, and controlling high temperatures. Several full-size fac-simile charts and records are shown. The advantages obtained by the use of this pyrometer are summarized, the various parts are described, and price lists are included.

THE BILLINGS & SPENCER CO., Hartford, Conn. General catalogue of machinists' tools and drop forgings. The catalogue lists a large line of tools including pocket wrenches, S-wrenches, tap and reamer wrenches, pliers, wire-cutters, hammers, ratchet drills, lathe dogs, lathe tool-holders, hand vises, caliper squares, steel rules, surface gages, micrometer holders, pin vises, screw drivers, etc.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis., maker of electric controlling devices, has just issued a booklet—pigeon-hole size—descriptive of its line of electric crane controllers. In addition to full descriptions and illustrations of five types of crane and hoist controllers, the booklet contains connection and dimension diagrams, repair part charts, prices, net weight and shipping weight of apparatus, etc. An improved form of contactor for handling heavy currents is also described.

AMERICAN LOCOMOTIVE COMPANY, 111 Broadway, New York, has just issued the tenth of its series of catalogue pamphlets, which illustrates and describes the Prairie type locomotives built for various roads. This pamphlet contains half-tone illustrations and the principal dimensions, in tabulated form, of fifteen different designs of locomotives of this type, ranging in weights from 136,000 to 245,000 pounds. The usual style of pamphlet adopted by this company is followed, beginning with the description of this class of locomotives and presenting the advantages which it offers for fast freight and passenger service.

WESTERN ELECTRIC CO., Hawthorne, Ill. Booklet describing black enamel magnet wire designed to supersede cotton and silk insulated wire. This new development in insulated wire promises to make a great improvement in electrical apparatus. The black enamel wire occupies less space for the same cross section of wire than does either cotton or silk insulated wire, and is less costly. The enamel insulation is an elastic, yet resistant and firmly adhering, film which will stand a temperature as high as 500 degrees F. for a considerable length of time without injury to its insulating qualities. Although it is not claimed that the black enamel wire is water-proof, it has a resistance to moisture far superior to cotton or silk insulation and for that reason is better adapted to moist climates. Other features of this new magnet wire are described in the booklet which is sent to any address on request.

CHARLES H. BESLY & CO., 15-17-19-21 South Clinton St., Chicago, Ill. New 1908 catalogue "D" of fine tools. This is a cloth-bound book of standard size, 6 inches x 9 inches, containing 323 pages of descriptive matter and a complete index thereto. The first section of the catalogue is devoted to brass and copper in sheet, rod, wire and tubing, as carried by this company. The following sections take up drills; reamers; taps; dies; screw plates; chucks of all forms; screws; wrenches; files; vises; clamps; the various lines of small tools as used in the metal-working shops; laboratory specialties; tool-holders; tool-chests; and engineers' supplies. Over 42 pages are devoted to the Besly spiral disk grinders and the Besly band wheels, showing some new forms and types never before illustrated. Polishing and plating supplies, parallel clamps, "Helmet No Rust" and Helmet oil are also treated of, and tables containing information relating to the goods shown in the catalogue are included. The company distributes this catalogue free upon application.

MANUFACTURERS' NOTES.

LA SALLE MACHINE & TOOL CO., La Salle, Ill., manufacturer of plain and surface grinders, has contracted for a 50 x 60-foot addition to its factory, which will be completed this fall.

THE JACOBS MFG. CO., Hartford, Conn., maker of the Jacobs improved drill chuck, is installing more machinery and making additional tools and fixtures, which will largely increase the present output.

EDWIN R. KENT CO., Chicago, dealer in Allen's high-speed steel, has removed from Canal St. to 23 West Randolph St. The company now occupies an entire building and has much better facilities for taking care of its business.

THE AMERICAN PEAT ASSOCIATION will hold a meeting October 23 to 26 at the Jamestown Exposition, where the United States Geological Survey has established a fuel-testing plant. A peat exhibit will be made in the Mines and Metallurgy Building. Further information will be given by Dr. Joseph H. Pratt, Mines and Metallurgy Building, Jamestown Exposition, Va., or by Mr. Julius Bordollo, temporary secretary and treasurer, Kingsbridge, New York.

THE W. P. DAVIS MACHINE CO., Rochester, N. Y., has completed its new plant which is erected just north of the New York Central station on St. Paul St. The plant consists of an office and show room building 40 x 160 feet, four stories high; main shop building 150 feet square, steel frame, one story high with concrete roof, fire-

CONTENTS FOR OCTOBER.

proof construction; blacksmith shop and pattern storage building, 40 x 80 feet, three stories high, built of brick. The machine shop is supplied with a ten-ton traveling crane, and the entire plant is equipped with modern up-to-date tools throughout.

The Rock Island Tool Co., Rock Island, Ill., is about to erect a new factory costing $23,000. The machine shop will be 80 x 150 feet; foundry, 60 x 120 feet; pattern-shop, 30 x 30 feet; two-story office building, 30 x 30 feet. The company started business in March, 1907, building automatic swivel vises, with Mr. C. E. Shields as the secretary and manager, and it has already outgrown its present quarters. Seventy-five men are now employed. Several new models of the vise will be put on the market at an early date, and the new plant is expected to be ready about January 1, 1908.

Standard Roller Bearing Co., Philadelphia, Pa., has recently made large additions to its plant and now has the largest works of its kind in the world. The buildings extend over one-half mile of ground from end to end, having a floor space of over 500,000 square feet. The concern now employs over 1,500 men. The business has grown to such proportions as to necessitate the establishing of a thoroughly organized department of publicity. The new department will be conducted by Mr. C. Dickens Sternfels, who has been identified in a similar capacity with the Arthur Koppel Co., Pittsburg, Pa., for the past three years.

The Cleveland Twist Drill Co., Cleveland, Ohio, has purchased the business, stock, raw material, patents and good will of the Three Rivers Tool Co., Three Rivers, Mich. The machinery will be moved and immediately installed at the Cleveland works, and the manufacturing resumed with as little interruption as possible. Mr. J. G. Matthews, former manager of the Three Rivers plant, will have charge of the new department. Hereafter the reamer manufactured will be known as the "Peerless." It has an interesting construction. The blades are of high-speed steel brazed into a body of tough steel, with the result that the parts are united into one solid piece. The body of the reamer is of low carbon steel, especially selected for elasticity and shock-resisting qualities. It is believed that the combination of high-speed blades and an elastic body makes the ideal tool, adding longer life and increased efficiency. Two distinct types of "Peerless" reamers will be made—both intended for hand and machine work; the one is ordinarily termed solid, and the other expansion. The process of brazing the blades is the same in each. The expansion type is expanded by means of a plug, threaded at the point, with a taper seat near the top. The increase of diameter takes place at the extreme point, or in the part where the cutting is done.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

ADVICE.—Mechanical, both Practical and Technical. Tell me your needs; I'll tell you the cost. Results or no fee. JOS. V. WOODWORTH, M.E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

A MACHINIST AND DRAFTSMAN of 20 years experience desires a position with a manufacturing firm. Has first-class mechanical and business ability, self acquired technical education, and is qualified to take charge of a machine shop or manage a manufacturing plant. Address DESIGNER, care Machinery, 49-55 Lafayette St., New York.

A WELL-EQUIPPED UP-TO-DATE MACHINE SHOP, manufacturing high grade specialties, desires to secure the manufacture of hardware specialties, model machines, tools, punch press work, dies, etc. Address PENNSYLVANIA SPECIALTY MFG. CO., care Machinery, 49-55 Lafayette St., New York.

DON'T BUILD YOUR MACHINE BY GUESSWORK! Drawings are less expensive to alter than castings. Design and working drawings for engines and machinery. Correspondence solicited; terms reasonable. Box 191, Plainville, Conn.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity, twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

FOREMAN, seven years experience in first-class tool shop, wishes to make a change; would like position as general foreman or assistant superintendent. Address Box 142, care Machinery, 49-55 Lafayette St., New York.

FOR SALE.—Seven Marburg Rotary Pumps, new; capacity, 300 gallons per minute; 800 R. P. M. Will sell cheap. ELECTRIC BOAT CO., Quincy, Mass.

FOR SALE.—Cyclopedia of Modern Shop Practice. A complete reference work for machinists, foundrymen, etc. Leather binding. Four volumes. Cost $18.00. Will sell for $6.00. Address "M. R. T.," Box 425, Chicago, Ill.

FOR SALE.—Cyclopedia of Engineering. Four volumes. Bound in three-quarters red morocco leather. Used but little and are in first-class condition. Cost new $19.00. Will sell for $9.00. Address "F. T. B.," care Machinery, 49-55 Lafayette St., New York.

FOR SALE.—A twelve-volume engineering library. Steam, electrical, mechanical. Cost new $60.00. Is in first-class condition. Will sell for $18.00. Address "A. R. F.," care Machinery, 49-55 Lafayette St., New York.

FOR SALE.—Nine dollars gets an up-to-date set of books on electricity. Five volumes. Bound in morocco leather. Cost new $19.00. Are in excellent condition. Address "A. M. L.," care Machinery, 49-55 Lafayette St., New York.

FOR SALE.—Cheap, 500 horse-power marine boiler. Address ELECTRIC BOAT CO., Quincy, Mass.

FOR SALE.—New Loew Victor Hand-Power Pipe Machine, cutting from one to four-inch. Address Box 143, care Machinery, 49-55 Lafayette St., New York City.

MACHINISTS AND DRAFTSMAN'S TABLE of U. S. Standard steam, gas and water pipes and tapping sizes; 5c. in stamps. E. E. MEYER, Allegheny, Pa.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge, and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

PRACTICAL AND THEORETICAL ADVICE on mechanical or manufacturing problems. Write me. Cost given. Results guaranteed. W. M. DOLLAR, Industrial Engineer, Buffalo, N. Y.

STRUCTURAL DRAFTING, $1.00; Lettering, 25c; Trigonometry Simplified, 50c; Dimensions of Pipe, Fittings and Valves, 50c. NATIONAL BOOK CO., Box O., Cleveland, O.

SUPERINTENDENTS AND FOREMEN.—Men of strong executive ability, capable of handling a large force of men to advantage, are wanted by some of the manufacturers and contractors we serve. Salary $1,000–$5,000. Offices in twelve cities. Write us to-day. HAPGOODS, 305 Broadway, New York.

TOOLMAKER.—Mechanic possessing inventive ideas, labor-saving devices, excellent executive ability, capable of conducting a shop, desires position as superintendent, foreman, or some responsible position based on above representations. Address, GEORGE C. E. KREDEL, 80 Tracey Ave., Newark, N. J.

WANTED.—Agents in every shop to sell Calipers. Liberal pay. Address E. G. SMITH CO., Columbia, Pa.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Hand Book of Practical Mechanics" now ready. Machinists say: "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—Copies of Railway Machinery for July, 1907, also from July, 1906, to December, 1906, inclusive. Address with price. SUBSCRIPTION DEPT., Machinery, 49-55 Lafayette St., New York.

WANTED.—Position in drawing room. Two years technical school, three years machine shop experience. I. C. S. graduate. Age twenty-two. Prefer east. R. E. FORBIS, 532 Harrison St., Portsmouth, Va.

WANTED.—Machine Work. Correspondence solicited with parties who want light machine work of any kind to order. We make a specialty of fine tool and jig work, sheet metal stamping, automobile parts, perfecting of patents and duplicate work of all kinds. DAWSON MACHINE CO., Sargent St., Worcester, Mass.

WANTED.—Copy of Machinery, Engineering Edition, for September, 1906; will be paid well. BORG, 402 Hay Street, Wilkinsburg, Pa.

WANTED.—High grade machine work, especially for screw machines and turret lathes. We can refer to a very well known line of high grade tools now on the market to demonstrate that we are able to do the highest grade of interchangeable work. Address Box 144, care Machinery, 49-55 Lafayette St., New York.

WANTED—A Foreman and Machinist for a cream separator factory. Men of experience and ability only wanted. DAIRY QUEEN MFG. CO., Lebanon, Ind.

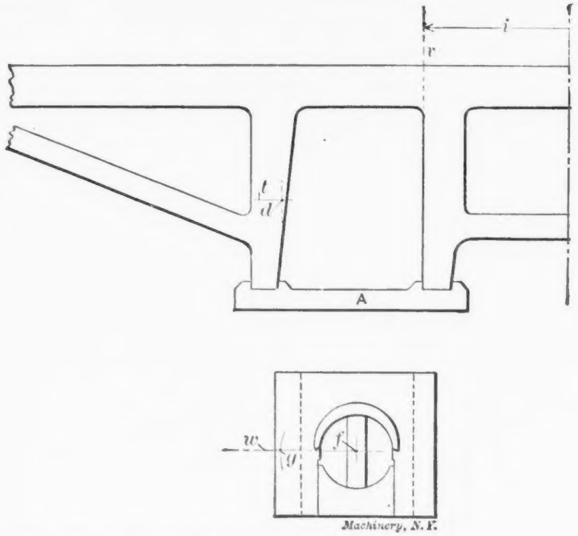
CUT OUT ON THIS LINE.

CUT OUT ON THIS LINE.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 43.

Franklin D. Jones. MACHINERY, November, 1907.



To Line Up Locomotive Shoes and Wedges.

1. Run fine lines through each cylinder, and let them extend back of the main jaws. Set the lines perfectly central with the front and back counterbores of the cylinders.

2. Place a straight-edge, *B*, upon the supports *C*, and across the faces of the front main jaws. Set the straight-edge *B* at right angles to the lines through the cylinders.

3. Scribe horizontal lines *t* on the inside and the outside of all back jaws, keeping the distance from the top of the frame to these lines, equal to the distance from the top of the frame to the center of the straight-edge *B*.

4. Hold a pair of hermaphrodite calipers against the straight-edge *B*, and scribe arcs intersecting those horizontal lines *t* which are on the main back jaws. The points of the intersection of these lines, will be the square centers *a*.

5. Remove the straight-edge *B*, and clamp both main wedges *D* in position, placing them about ¼ inch above the pedestal braces, as shown by the dotted lines. Place a square on top of the frame, and scribe a line *r*, from the inner top edge of each main wedge *D*. Remove the wedges.

6. Insert between the pedestal braces and the frames, on both sides, wooden centers *E*, placing them flush with the outside of the frames. Scribe lines *s*, *u*, and *v*, from the faces of each front jaw, on both sides of the engine. With a pair of dividers, locate the center *b*, midway between the lines *r*, and *s*. Scribe a line at right angles to the top of the frame, through the center *b*, and down far enough to intersect the horizontal line *t*. The intersection of these two lines is the jaw center *c*. In a similar manner, locate the jaw center on the opposite side of the engine. With a pair of dividers, see if the distances from the square centers *a*, to the jaw centers *c*, are equal on both sides of the engine. If they are not,

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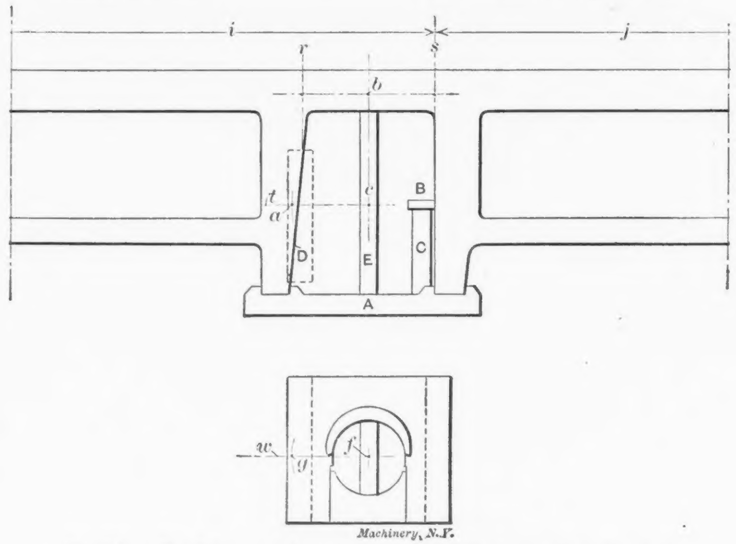
SHOP OPERATION SHEET NO. 44.

Franklin D. Jones. MACHINERY, November, 1907.



To Line Up Locomotive Shoes and Wedges (Continued).

move one jaw center forward, and the other backward, one-half the difference, making the distances equal.

7. Set a long pair of trammels, equal to the distance *i*. Try the corresponding distance on the opposite side of the engine. If these two distances are not equal, move the trammel point one-half the difference; then with one trammel point into the main square center *a*, scribe an arc intersecting the horizontal line *t*. The point of intersection will be the square center *d*. In a similar manner, locate a square center on the inside of the jaw, also on both sides of the opposite jaw. Now set the trammels to the distance *j*, try the opposite side; if there is a difference, again move the trammel point one-half this difference, and proceed to locate square centers *e* as before.

NOTE.—When the connecting-rods have solid ends, set the trammels to the length of the rods when locating square centers *d*, and *e*, from the main square center *a*.

8. Place all driving boxes on the floor in their respective positions, with their tops toward the rail, and their outer sides upward. Locate the centers *f*, which represent the centers of the axles. On the outside back flange of each box, scribe lines *w*, through the centers *f*, and at right angles to the back edge of the flange. Now set a pair of dividers equal to the distance from the main jaw center *c*, to the square center *a*. Transfer this measurement to all the driving boxes, locating the centers *g*.

9. Remove the wooden centers *E*, and clamp all the shoes in their respective positions. Hold the transfer plate *F* against the front face of one of the driving boxes, and set the hermaphrodite calipers to the distance *k*. Now insert the point of the calipers into the square center of the jaws to

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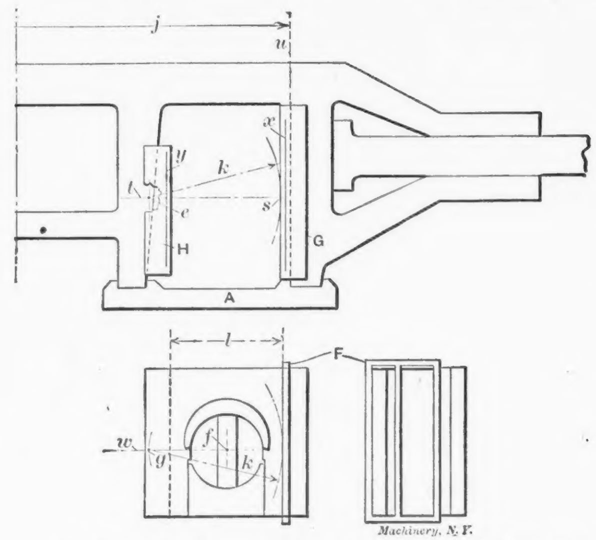
SHOP OPERATION SHEET NO. 45.

Franklin D. Jones. MACHINERY, November, 1907.



To Line Up Locomotive Shoes and Wedges (Continued).

which the box belongs—say square center *e*—and determine the thickness of the liner to be riveted to the shoe. Remove the shoe and rivet a liner of the required thickness to the back, allowing an extra 1/32 inch for planing the face of the shoe.

10. After liners have been riveted to all the shoes, again clamp them in position, and beginning with, say shoe *G*, chip away a small spot *s*, on the face of the shoe just opposite the square center *e*. Chip and file this spot, until the hermaphrodite calipers set to distance *k*, touch it lightly. Chip and file a second spot, opposite the inside square center, until the hermaphrodites (calipering from the inside square center) touch the spot lightly as before. Scribe a line *x*, which is at right angles to the top of the frame, on the outside flange of the shoe.

11. Clamp all wedges in position, placing them ¼ inch above the pedestal braces. Caliper each box, and determine the thickness of the liner to be riveted to each respective wedge, adding enough to allow for planing.

12. After liners have been riveted to all the wedges, again clamp them in position, and beginning with say wedge *H*, chip and file spots on the face of the wedge, opposite the spots *s* on the face of the shoe, making the distance between them equal to the thickness *l*, of the driving box. Scribe a line *y* on the flange of the wedge, parallel to the line *x*.

NOTE.—After all the shoes and wedges have been treated in this way, they are ready to be planed. They will be set lengthwise on the planer by the lines *x* and *y*, and crosswise by the spots *s*, which are parallel with the square centers. The planer tool should just scrape these spots, allowing them to remain visible.

MACHINERY'S

Contributions and data suitable for publication in these Data Sheets

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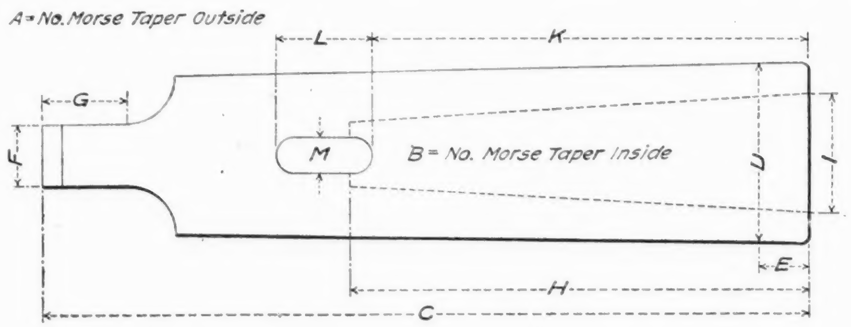
CREASE HERE

MORSE TAPER SOCKETS.



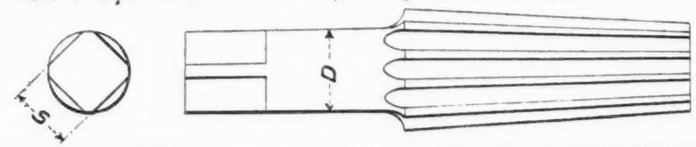
A	B	C	D	E	F	G	H	I	K	L	M
2	1	3 5/8	.700	3/4	1/4	3/8	2 3/16	.475	2 1/16	3/4	.213
3	1	3 3/4	.938	3/16	5/16	7/16	2 3/16	.475	2 1/16	3/4	.213
3	2	4 1/4	.938	11/16	5/16	7/16	2 5/8	.700	2 1/2	7/8	.260
4	1	4 3/4	1.231	1/4	15/32	1/2	2 3/16	.475	2 1/16	3/4	.213
4	2	4 3/4	1.231	1/4	15/32	1/2	2 5/8	.700	2 1/2	7/8	.260
4	3	5 1/4	1.231	3/4	15/32	1/2	3 1/4	.938	3 1/16	1 1/16	.322
5	1	6	1.748	1/4	5/8	5/8	2 3/16	.475	2 1/16	3/4	.213
5	2	6	1.748	1/4	5/8	5/8	2 5/8	.700	2 1/2	7/8	.260
5	3	6	1.748	1/4	5/8	5/8	3 1/4	.938	3 1/16	1 1/16	.322
5	4	6 3/8	1.748	5/8	5/8	5/8	4 1/8	1.231	3 7/8	1 1/4	.478
6	1	8 5/16	2.494	5/16	3/4	7/8	2 3/16	.475	2 1/16	3/4	.213
6	2	8 5/16	2.494	5/16	3/4	7/8	2 5/8	.700	2 1/2	7/8	.260
6	3	8 5/16	2.494	5/16	3/4	7/8	3 1/4	.938	3 1/16	1 1/16	.322
6	4	8 5/16	2.494	5/16	3/4	7/8	4 1/8	1.231	3 7/8	1 1/4	.478
6	5	8 11/16	2.494	11/16	3/4	7/8	5 1/4	1.748	4 15/16	1 1/2	.635

PUNCH O PUNCH O

CREASE HERE

SQUARES ON SHANKS OF REAMERS AND TAPS.

Sizes of Squares of Tools Corresponding to certain Shank Diameters



Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square
D	S	D	S	D	S	D	S	D	S	D	S	D	S
1/16	3/64	27/64	5/16	25/32	19/32	1 9/64	55/64	1 1/2	1 1/8	2 7/32	1 43/64	2 15/16	2 13/64
5/64	1/16	7/16	21/64	51/64	19/32	1 5/32	7/8	1 17/32	1 5/32	2 1/4	1 11/16	2 31/32	2 15/64
3/32	5/64	29/64	11/32	13/16	39/64	1 11/64	7/8	1 9/16	1 11/64	2 9/32	1 23/32	3	2 1/4
7/64	5/64	15/32	23/64	53/64	5/8	1 3/16	57/64	1 19/32	1 13/64	2 5/16	1 47/64	3 1/32	2 9/32
1/8	3/32	31/64	23/64	27/32	41/64	1 13/64	29/32	1 5/8	1 7/32	2 11/32	1 49/64	3 1/16	2 19/64
9/64	7/64	1/2	3/8	55/64	41/64	1 7/32	59/64	1 21/32	1 1/4	2 3/8	1 25/32	3 3/32	2 21/64
5/32	1/8	33/64	25/64	7/8	21/32	1 15/64	59/64	1 11/16	1 17/64	2 13/32	1 13/16	3 1/8	2 11/32
11/64	1/8	17/32	13/32	57/64	43/64	1 1/4	15/16	1 23/32	1 19/64	2 7/16	1 53/64	3 5/32	2 3/8
3/16	9/64	35/64	13/32	29/32	11/16	1 17/64	61/64	1 3/4	1 5/16	2 15/32	1 55/64	3 3/16	2 25/64
13/64	5/32	9/16	27/64	59/64	11/16	1 9/32	31/32	1 25/32	1 11/32	2 1/2	1 7/8	3 7/32	2 27/64
7/32	11/64	37/64	7/16	15/16	45/64	1 19/64	31/32	1 13/16	1 23/64	2 17/32	1 29/32	3 1/4	2 7/16
15/64	11/64	19/32	29/64	61/64	23/32	1 5/16	63/64	1 27/32	1 25/64	2 9/16	1 59/64	3 5/16	2 31/64
1/4	3/16	39/64	29/64	31/32	47/64	1 21/64	1	1 7/8	1 13/32	2 19/32	1 61/64	3 3/8	2 17/32
17/64	13/64	5/8	15/32	63/64	47/64	1 11/32	1 1/64	1 29/32	1 7/16	2 5/8	1 31/32	3 7/16	2 37/64
9/32	7/32	41/64	31/64	1	3/4	1 23/64	1 1/64	1 15/16	1 29/64	2 21/32	2	3 1/2	2 5/8
19/64	7/32	21/32	1/2	1 1/64	49/64	1 3/8	1 1/32	1 31/32	1 31/64	2 11/16	2 1/64	3 9/16	2 43/64
5/16	15/64	43/64	1/2	1 1/32	25/32	1 25/64	1 3/64	2	1 1/2	2 23/32	2 3/64	3 5/8	2 23/32
21/64	1/4	11/16	33/64	1 3/64	25/32	1 13/32	1 1/16	2 1/32	1 17/32	2 3/4	2 1/16	3 11/16	2 49/64
11/32	17/64	45/64	17/32	1 1/16	51/64	1 27/64	1 1/16	2 1/16	1 35/64	2 25/32	2 3/32	3 3/4	2 13/16
23/64	17/64	23/32	35/64	1 5/64	13/16	1 7/16	1 5/64	2 3/32	1 37/64	2 13/16	2 7/64	3 13/16	2 55/64
3/8	9/32	47/64	35/64	1 3/32	53/64	1 29/64	1 3/32	2 1/8	1 19/32	2 27/32	2 9/64	3 7/8	2 29/32
25/64	19/64	3/4	9/16	1 7/64	53/64	1 15/32	1 7/64	2 5/32	1 5/8	2 7/8	2 5/32	3 15/16	2 61/64
13/32	5/16	49/64	37/64	1 1/8	27/32	1 31/64	1 7/64	2 3/16	1 41/64	2 29/32	2 3/16	4	3

DATA SHEET.

...are solicited. Payment will be made for all accepted matter.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

PUNCH O PUNCH O

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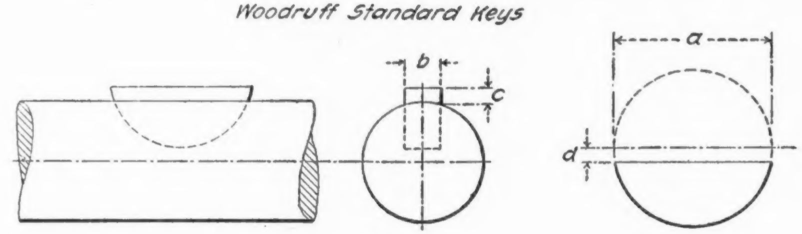
WOODRUFF KEYS.—I.

Woodruff Standard Keys



No. of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made, to top of key	No of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made, to top of key
	a	b	c	d		a	b	c	d
1	1/2	1/16	1/32	3/64	B	1	5/16	5/32	1/16
2	1/2	3/32	3/64	3/64	16	1 1/8	3/16	3/32	5/64
3	1/2	1/8	1/16	3/64	17	1 1/8	7/32	7/64	5/64
4	5/8	3/32	3/64	1/16	18	1 1/8	1/4	1/8	5/64
5	5/8	1/8	1/16	1/16	C	1 1/8	5/16	5/32	5/64
6	5/8	5/32	5/64	1/16	19	1 1/4	3/16	3/32	5/64
7	3/4	1/8	1/16	1/16	20	1 1/4	7/32	7/64	5/64
8	3/4	5/32	5/64	1/16	21	1 1/4	1/4	1/8	5/64
9	3/4	3/16	3/32	1/16	D	1 1/4	5/16	5/32	5/64
10	7/8	5/32	5/64	1/16	E	1 1/4	3/8	3/16	5/64
11	7/8	3/16	3/32	1/16	22	1 3/8	1/4	1/8	3/32
12	7/8	7/32	7/64	1/16	23	1 3/8	5/16	5/32	3/32
A	7/8	1/4	1/8	1/16	F	1 3/8	3/8	3/16	3/32
13	1	3/16	3/32	1/16	24	1 1/2	1/4	1/8	7/64
14	1	7/32	7/64	1/16	25	1 1/2	5/16	5/32	7/64
15	1	1/4	1/8	1/16	G	1 1/2	3/8	3/16	7/64

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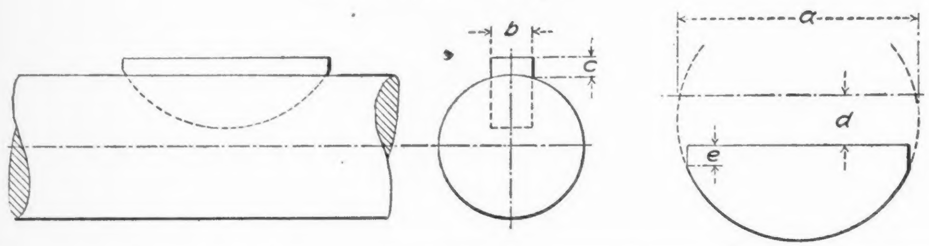
WOODRUFF KEYS.—II.

Woodruff Special Keys.



No. of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made, to top of key	Width of Flat	No. of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made, to top of key	Width of Flat
	a	b	c	d	e		a	b	c	d	e
26	2 1/8	3/16	3/32	17/32	3/32	31	3 1/2	7/16	7/32	13/16	3/16
27	2 1/8	1/4	1/8	17/32	3/32	32	3 1/2	1/2	1/4	13/16	3/16
28	2 1/8	5/16	5/32	17/32	3/32	33	3 1/2	9/16	9/32	13/16	3/16
29	2 1/8	3/8	3/16	17/32	3/32	34	3 1/2	5/8	5/16	13/16	3/16
30	3 1/2	3/8	3/16	13/16	3/16						

Standard Keys to use with various diameter shafts

Diameter of Shaft	Number of Keys	Diameter of Shaft	Number of Keys	Diameter of Shaft	Number of Keys
5/16 – 3/8	1	7/8 – 15/16	6, 8, 10	1 3/8 – 1 7/16	14, 17, 20
7/16 – 1/2	2, 4	1	9, 11, 13	1 1/2 – 1 5/8	15, 18, 21, 24
9/16 – 5/8	3, 5	1 1/16 – 1 1/8	9, 11, 13, 16	1 11/16 – 1 3/4	18, 21, 24
11/16 – 3/4	3, 5, 7	1 3/16	11, 13, 16	1 13/16 – 2	23, 25
13/16	6, 8	1 1/4 – 1 5/16	12, 14, 17, 20	2 1/16 – 2 1/2	25